

ANNALS of SURGERY

A Monthly Review of
Surgical Science and Practice

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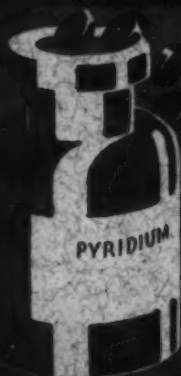
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Official Publication of the American Surgical Association, of the
New York Surgical Society and the Philadelphia Academy of Surgery

CONTENTS

- Delayed and Non-Union in Fractures in the Adult—*Clay Ray Murray, M.D., New York, N. Y., 961*
- Fractures with Special Reference to the Hip, Ankle and Elbow—*Melvin S. Henderson, M.D., Rochester, Minn., 968*
- Malunion of Fractures of the Femur—*Russel H. Patterson, M.D., New York, N. Y., 984*
- An Ambulatory Treatment of Malleolar Fractures—*Arthur Krida, M.D., New York, N. Y., 998*
- Fractures of the Scapula—*Robert T. Findlay, M.D., New York, N. Y., 1001*
- Calcification in Callus Formation and Fracture Repair—*Richard M. Berg, M.D., Portland, Ore., I. Newton Kugelmass, M.D., New York, N. Y., 1009*
- Surgical Management of Cranial Injuries—*John Stewart Rodman, M.D., Philadelphia, Pa., 1017*
- Apathetic Thyroidism—*Frank H. Lahey, M.D., Boston, Mass., 1026*
- Therapeutic Failures after Operation for Hyperthyroidism—*John Rogers, M. D., New York, N. Y., 1031*
- Results of Thyroidectomy—*Alfred H. Noehren, M.D., Buffalo, N. Y., 1045*
- Bilateral Empyema of the Pleural Cavities—*E. Lawrence Keyes, M.D., New York, N. Y., 1050*
- Subcutaneous Rupture of the Spleen—*Harold J. Shelley, M.D., New York, N. Y., 1054*
- Intra-Abdominal Apoplexy—*William T. Green, M.D., John H. Powers, M.D., Boston, Mass., 1070*
- Subphrenic Abscess—*Henry P. Brown, Jr., M.D., Philadelphia, Pa., 1075*
- The Management of Patients with Gastric and Duodenal Ulcers—*J. William Hinton, M.D., New York, N. Y., 1082*
- Duodeno-jejunostomy as a Substitute for Gastroenterostomy in Certain cases of Duodenal and Gastric Ulcer and Apparent Obstruction of the Stomach—*Addison G. Brenizer, M.D., Charlotte, N. C., 1086*
- Transactions of the Philadelphia Academy of Surgery—*Stated Meeting, Jan. 5, 1931, 109*
- Transactions of the New York Surgical Society—*Stated Meeting, Dec. 10, 1930, 1099*
- Brief Communications—Intestinal Obstruction complicating Acute Appendicitis in a child of three years—*Frederick Christopher, M.D., Winnetka, Ill. "Anchoring" Radon Seeds a Base of Tongue—Joseph Muir, M.D., New York, N. Y. Necrosis of Ureter—Thomas N. Hepburn, M.D., Hartford, Conn. Mikulic Operation Clamp—Carl R. Steinke, M.D., Akron, Ohio—Disposition of the Head of the Fibula in High Amputations of the Leg—George E. Marks, New York City, 1109*
- Book Reviews—Abdomino-Pelvic Diagnosis in Women—*Albert M. Judd. Collected Paper from the Second Surgical Division of the New York Hospital—James T. Pilcher, 112*

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ANNALS *of* SURGERY

VOL. XCIII

MAY, 1931

No. 5

DELAYED AND NON-UNION IN FRACTURES IN THE ADULT*

BY CLAY RAY MURRAY, M.D.

OF NEW YORK, N. Y.

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IN THE CITY OF NEW YORK

THE results of trauma occupy a unique position among surgical conditions in this age of economic urge, since they frequently are directly traceable to the patient's occupation and result in temporary or permanent disability. A generation ago this mattered but little to anyone except the individual involved—he was essentially responsible for his own medical care—his was the worry as to time lost, doctors' bills, and eventual outcome.

With the universal enactment of some form of workmen's compensation legislation, these problems with their financial burden have been shifted from the individual to the employer and his insurance medium—they have become business problems.

With this shift in responsibility has come the realization of the tremendous economic loss through injury each year, and with that realization has come a demand upon the profession from organized industry for a shortening of convalescence or disability time and a diminished percentage of permanent disabilities and, by these means, a reduction in treatment costs.

One of the frequent factors with which we have to deal in meeting these demands is delayed union and non-union in fractures. I say frequent, because I use the term "delayed union" in the sense of prolonged healing time. It will, therefore, include many fractures which heal in what is called the normal or average time for the region involved, where that time is an extended period.

I feel that the problem presented to us by delayed and non-union is primarily not one of how to treat these conditions, but rather of how to prevent their occurrence and how to reduce the time required for healing in those regions where it is expected that normal or average healing time will be prolonged. I might point out the fact that to industry and to the patient the time taken to secure a given result may be just as important an economic factor as is the result obtained. In the satisfied contemplation of end-results we are apt to overlook this aspect of the case. It is equally true that, in general, our efforts to maintain adequate bony anatomy during a prolonged healing time are reflected in functional inactivity of the part as a whole, with consequent soft-part disturbances from which it may take the patient considerable time to recover. Hence the so-called "after-treatment" of fractures.

We are dealing essentially with a healing process of dual nature. A wound

* Read before the New York Surgical Society, April 8, 1931.

of bone must heal, and the healing tissue must be fortified by deposited calcium to constitute a rigid fusion of the wound margins. In experimental work presented at the Scientific Exhibits of the American Medical Association in 1927, 1928 and 1929,¹ I adduced adequate evidence of the fact that all fractures heal unless there exists a physical or chemical bar to the growth of granulation tissue, and that the healing process is, as with any other wound, the result of granulation tissue growth. The physical bar may exist as interposed tissue or massive death of tissue in the fracture region. The chemical bar may be infection or any other chemical agent which destroys fibrin or growing cells.

The terms delayed union and non-union as commonly used refer to delay in or failure of the process of calcium deposition in this healing tissue to form bone. To logically treat or prevent delayed or non-union we must, therefore, understand what happens during this process.

Although today there exists, to say the least, serious doubt as to the existence in the adult human of a specific bone-forming cell—an osteoblast—it is commonly assumed that the healing of a fracture occurs through an actual growth of bone from the site of fracture. I do not believe this to be true, and in a previously published article² I have shown that as much as 60 per cent. of the healing tissue which is subsequently calcified may be derived from tissues outside the bone in muscle and fascial planes and that any tissue not so derived comes from the *soft parts of the bone*—the so-called endosteum, the periosteum and the areolar tissue about the blood-vessels.

I presented evidence at the same time supporting the view that this living tissue was calcified without the activity of any specific cell and that the calcium utilized was derived from the demonstrably dead bone ends at the fracture site through obvious autolysis, and not from the blood-stream calcium which is the source of the calcium used in the ordinary growth structural changes in bone; and that in experimental animals as much as 2.5 centimetres of bone with its periosteum could be removed and the gap allowed to heal in the presence of an artificially supplied calcium source placed therein with a resultant solid bony union of the gap.

In another paper³ I cited the evidence to support the view that bone can be formed anywhere in the adult body if four requisite conditions are fulfilled. They are: 1, Death of tissue; 2, granulation tissue growth; 3, a local concentration of calcium to act as a calcium source; 4, a proper pH of the tissue fluids in the specific region involved, which is, in part, dependent upon the lymphatic and vascular circulatory status of the part from both a qualitative and quantitative viewpoint. On the basis of this conception I was able to demonstrate in 1930⁴ the production of experimental myositis ossificans with true bone formation without the introduction in the muscle of any bone elements whatever.

Going a step further, utilizing tissue culture as a medium of investigation, I have presented evidence to show that the morphological counterpart of new bone can be produced in a plasma medium in the total absence of cells by

DELAYED UNION IN FRACTURES

purely biochemical means—artificially creating the factors which I have cited as essential for new bone formation—and have produced evidence to support the viewpoint that the enzyme phosphatase, which is held by many as responsible in the mechanism of depositing calcium in the tissues to form bone, is liberated by the death of cells rather than as a product of their living metabolism.⁵

The amount of callus produced in any given fracture, and the rapidity of its production and increasing density, would appear in the light of the above data to depend upon the mechanical factors cited, the possible sources for granulation tissue growth and its unimpeded progress, the rate of autolysis of dead bone at the fracture site (influenced by tissue fluid pH at that site and the density of the bone to be autolyzed) to give available calcium for deposition in the granulation tissue, and the proper mechanism of deposition involving the question of enzyme activity and the proper pH of tissue fluids for that activity. It would then appear to be a purely local process, independent of factors outside the affected area.

This agrees with clinical facts. Delayed union and non-union are, if we exclude the cases in which actual healing is prevented by the mechanical or chemical factors cited, phenomena of certain locations in the body and not of individual patients, if reasonably proper treatment methods are used. The evidence on this point is overwhelming. The patient with a fracture of the intertrochanteric region of the femur—regardless of age, general health, specific disease or blood chemistry—heals by bony union so universally that it is jocularly said that he heals despite the treatment accorded. In the patient with a fracture two inches away—in the so-called intracapsular portion of the neck—we look forward at best to a slow formation of scanty callus, and we expect a large percentage risk of non-union or even bone absorption. And in this group of neck fractures we have no criterion whereby we can say what is going to happen in any given patient. We have carefully observed our patients from this standpoint. We have seen a patient of twenty-eight in perfect health go on to a non-union, while an octogenarian dying at nine weeks from intercurrent disease showed at autopsy a solid bony healing under identical treatment methods. A woman of forty-eight under ideal conditions had extensive absorption of the neck at eight weeks, while a coincident case in a senile woman of seventy-three, who had a hemiplegia a few days after her spica was applied and then developed a pyonephrosis with a daily temperature of 103° to 105° for the next six weeks, during which time she was in coma and completely involuntary, at eight weeks had evidence of bony healing and is today walking about on a perfectly good femoral neck.

What difference exists between the neck of the femur and the intertrochanteric region? The neck is surrounded by the dense fibrous reflection of the capsule of the joint. When it is broken it has only its own meagre soft parts and this dense fibrous tissue as a source for granulation tissue healing. It, therefore, never shows much callus. Its blood supply is minimal to begin with. Depending upon the damage inflicted by the original injury,

or that subsequently allowed or inflicted by improper treatment, this is cut down to a varying degree, and may be qualitatively changed as well. The calcium which is demonstrably autolyzed from the obvious dead bone at the fracture site cannot be utilized because of tissue pH conditions. There is an additional factor—the presence of synovial fluid. Cells cannot grow in a fluid medium with any degree of success and so tissue growth is hindered. Synovial fluid acts not as a deterrent to *bone* growth, but to *any* growth. This condition may well be reflected in other regions in the presence of marked oedema of the part.

The intertrochanteric region is buried in large vascular muscle bellies which surround the fracture site on every aspect. They are an adequate source for profuse granulation tissue growth and provide tremendous accessory circulation to make up for the damage done by trauma. The calcium autolyzed from the dead bone at the fracture site is readily made use of and so we see a large mass of callus, rapidly calcified, as a characteristic of the healing process.

Fractures at the junction of the middle and lower thirds of the tibia are characteristically slow in union and frequently show non-union. They are in that region where the inner aspect of the bone is covered by skin only and where the other two faces are covered principally by tendinous structures or narrowing muscle bellies at their junction with tendons. The area of muscle attachments is higher up. So is the region for rapid healing time. Moreover, if one observes the healing process in this region, one will note with marked regularity the formation of callus almost altogether on the outer and posterior faces of the bones, and to a minimal degree on the bare inner face. I desire to call particular attention to the fact that the circulation of the bone itself, as represented by the nutrient vessel, is apparently *not the important factor. It is the accessory circulation available from the soft parts, whether it come via the periosteum, or directly from torn soft parts without periosteal intervention.* Moreover, this circulatory factor plays its part primarily in its effect on the biochemistry of tissue fluids rather than on the nutrition of the part. This same story holds true in those other regions where we may expect slow union and fear non-union—the junction of the middle and lower thirds of the humerus, the scaphoid of the carpus, the head of the radius, the junction of lower and middle thirds of the forearm and the other typical regions.

Mechanical and chemical causes excluded, delayed union and non-union occur in places, not in people.

The viewpoint as to the source of the calcium utilized presented here is borne out clinically. An osteomalacia will heal fractures normally. There is one at our hospital now who, at a time when she had a blood calcium of 6 and a blood phosphorus of 1.2 and was actually running a negative balance, healed a fractured femur in five weeks.

A fragilitas ossium fractures with ease, but heals normally. So does a rachitic, as does a Paget's.

Again, there has yet to be shown any definite benefit from the administra-

DELAYED UNION IN FRACTURES

tion of any form of medication or treatment affecting the general body chemistry in delayed and non-unions. In my own experience, calcium in every conceivable form by mouth and by injection, cod-liver oil, irradiated Ergosterol, general light irradiation—none has produced any perceptible effect in preventing or curing delayed or non-union.

What, then, are we to do to prevent delayed union and non-union? I shall list below the objects of our concern.

1. Early and accurate replacement of displaced fragments, with assurance at the time of reduction that no interposition of tissue exists.
2. The restoration to normal of lymph and vascular circulation as rapidly as possible through elevation of the part and *early* physiotherapy, and the use of functional muscular activity.

This means bed treatment in the early stage of lower extremity fractures and in many upper extremity fractures. It means the more extensive use of traction-suspension as a method of treatment, particularly of skeletal traction with early active function in traction. It means the application of physiotherapy in the form of heat and light stroking massage starting as nearly coincident with the reduction as possible. It means the augmenting of, and substituting for, normal muscle activity by the use of electrical muscle stimulation to produce a spasmless contraction of a rhythmical type. This can be secured by the use of a sinusoidal current, by a Bristow coil or by a Smart coil in that order of efficiency.

3. The meticulous care of compounding wounds. Gentleness and conservation of sound tissue are not incompatible with thorough and efficient débridement. For the wound treatment I prefer to use a Carrel technic, but employ an inert solution such as saline, since I am convinced that Dakin's as commonly employed actually removes calcium from the fracture site. I am also quite sure that it pays to be conservative on the score of considering a débrided wound safe to sew up tightly.

Where facilities for operative work on bone are of high standard as regards equipment, technic and personnel, I feel that in open fractures rigid fixation of the fragments by plate or screw at the time of the débridement, with the wound left wide open, is justified by a saving in time through minimizing the chances for delayed or non-union by eliminating the foothold for infection engendered by constant movement of the fragments.

Such a procedure is never justified unless the facilities for carrying it out are as specified.

4. Where the facilities for operative work on bone are of the highest standard as regards equipment, technic and personnel, I believe that open operative reduction is indicated for all fractures with displacement in those regions where prolonged healing time is characteristic, provided there are no contraindications to operation in the particular case involved. I believe that such operative reduction should embody a dual procedure, aimed at the threat of delayed or non-union and malposition as well—following reduction osteo-periosteal grafts or chip should be placed and the fragments fixed rigidly

enough, if possible, so that early active function of the part can be started. The operative approach in proper hands provides the accessory source for granulation tissue and circulatory aid which is so essential to sound healing.

How are we to treat non-union? By creating the essential factors for new bone formation at the site of fracture—death of tissue, adequate granulation tissue—a local source of calcium and an adequate circulatory status for the part—not for the bone alone.

A bone graft, I have every reason to believe, does not grow, but acts as a calcium source for the calcification of the healing granulation tissue, and as one of the sources for the enzymes concerned in the calcium deposition. The removal of fibrous tissue and of sclerotic bone aids circulatory augmentation and granulation tissue growth and invasion. The graft is not efficient enough fixation to allow of early active function, particularly since osteoperiosteal or chip grafts should be the most effective type, and are so clinically and experimentally. I believe that, if possible, there should be added to the graft the rigid fixation obtainable from plate or screw, where it is feasible, followed by early active function. The post-operative treatment of the case should follow the lines laid down for the prevention of delayed and non-union in fresh fractures.

In this connection, and bearing out with gratifying success up to the present the conception of the factors involved in bone healing which have been put forward in this paper, I have presented before this Society two of a recent series of six cases in the characteristic tibial site of delayed or non-union—varying in time from seven weeks to nine months, four of them accompanied by low-grade chronic osteomyelitis due to compounding. Bony union has been secured in all cases within five to nine weeks by the following procedure:—the site of fracture has been widely exposed and the scar tissue from the soft parts removed. A saucerization of the bone in the fracture region back to the posterior cortex has been done. The extent of this has been gauged by the process present. The whole width and most of the depth of the tibia have been removed in each instance, and the extent of sclerotic or infected bone has gauged the length of the removed area. It has varied from 4 to about 7 inches. In some the wound has then simply been packed open with vaseline gauze, a plaster casing applied, and the part left undisturbed for three to four weeks. At the end of that time the packing has been removed and a new jacket applied. The cases so treated showed bony union, but with a greater or lesser saucer-like depression in the front of the tibia, depending upon the amount of bone removed. In other words, they healed by bone, but were deficient in amount. What we had done was simply to kill tissue, to kill some bone by our trauma, thereby supplying a calcium source, and to provide adequate granulation tissue access to the site and adequate circulation by our removal of scar tissue and sclerotic bone and by packing the wound open. Incidentally where infected bone was present, the element of infection had been removed. Qualitatively we had secured our result, but we had actually

DELAYED UNION IN FRACTURES

removed a tremendous area of bone instead of placing additional bone as grafts.

In others of the series we therefore did what was demonstrated in the cases presented—filled the gap in the tibia created by the saucerization with an artificial calcium source—a combination of powdered calcium triple phosphate and calcium carbonate well mixed with the blood allowed to fill up the cavity. In these cases we not only secured bony union, but filled the tibial defect with bone, at times even above the normal tibial surface level. In one case we introduced with the calcium a phosphatase derived from rat femora by water extraction under chloroform. It showed solid union in five weeks, with X-ray evidence of new bone in the cavity. I do not recommend the clinical use of these procedures on the basis of so few results. I am merely citing these cases in brief; a further report on a larger series is contemplated which will embody a discussion of details, and from which we may be able to draw definite conclusions. I must emphasize the fact that by removing a large area of bone in this way adequate access of granulation tissue and accessory circulation is allowed to the fracture site, and that the artificial calcium source in powdered form is readily permeable by the growing tissue. It is, however, unquestionably not utilized in the form in which it is placed in the cavity, but it apparently adequately functions as a source.

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FRACTURES WITH SPECIAL REFERENCE TO THE HIP, ANKLE AND ELBOW*

By MELVIN S. HENDERSON, M.D.

OF ROCHESTER, MINNESOTA

FROM THE SECTION ON ORTHOPEDIC SURGERY OF THE MAYO CLINIC

FRACTURES in America are today receiving better treatment than ever before. There is now an ample number of beds in hospitals for the sick and injured. The World War emphasized the fact that fractures taken care of in mass receive better care, and this has led to the institution and proper maintenance of fracture wards in most of the larger metropolitan hospitals. The American College of Surgeons and the American Medical



FIG. 1.—Balkan frame with elevator and trapeze.

Association, through their Fracture Committees, are bringing to the attention of the hospitals the necessity of good apparatus, splints and braces for the treatment of fractures. The overhead bed frame, often called the Balkan frame, is standard equipment in most hospitals.

In the Mayo Clinic we have developed a type of frame which serves our purpose best (Fig. 1). It is a frame of gas pipe with casters. It rests on the floor, which renders it more stable because the weight of the frame, weights, and so forth, is not carried by the bedstead. With casters on the uprights, frame and bed may be rolled about on the floor. The gas-pipe

* Presented before the Oklahoma City Clinical Society, November, 1930.

FRACTURES OF HIP, ANKLE AND ELBOW

uprights are angled inward at the top so that the ends of the frame do not project beyond the bed, an important factor when the bedroom is small. On such a frame any kind of suspension and traction can be arranged. The elevator for raising the bed frame is a worm gear apparatus and although it elevates the patient slowly, it locks securely in any position. Overhead beams are oak instead of metal, for safety when bedside röntgenologic apparatus is used. For fractures of the lower extremity a good supply of Thomas



FIG. 2.—Abduction splint with traction post.

MAYO CLINIC

extension splints, of different lengths and with rings of different sizes, is necessary so that they may be readily available for emergency use. We have found very useful in the treatment of fractures of the shoulder and of many fractures of the shaft of the humerus, a modification of the airplane splint which has on it, at the bottom of the arm-piece, an extension post for traction (Fig. 2). Stock splints of this type, as made by various commercial houses, have so many adjustments that the splints are cumbersome.

Delay in the institution of treatment I consider the chief cause of poor

end-results, but a nearly equal cause, I believe to be careless treatment by recognized and standard methods. However, if a fracture is compound, often treatment must necessarily be delayed, and the procedure of choice cannot always be used. Œdema, swelling, extensive hæmatoma, laceration of skin, injury to the nerves and poor general condition of the patient due to injuries sustained in the same accident which caused the fracture, all raise problems that are difficult to solve. After the fracture is reduced, the maintenance of reduction is not always easy, and traction in some form is often necessary. The type of treatment selected may be influenced by the social status or health of the patient, the equipment at hand, the mechanical ingenuity of the surgeon, and last but not least, the surgeon's willingness to accept the full responsibility of maintaining the fracture in its reduced condition. Patience and skill are necessary. I place patience first because no matter how skillful the surgeon may be in obtaining reduction it may go for naught if the fragments are permitted to become disengaged through faulty maintenance of position.

The advent of aseptic surgery and Röntgen-rays made possible a real departure from the standards established by centuries of practice in the treatment of fractures. Consequently, two methods have developed: reduction by open operation and reduction by the closed method. The popularity of each of the methods has risen and fallen in recent years, but the tendency now seems to be more toward the open method. An open operation to reduce a simple fracture which, however, may not be simple so far as reduction is concerned, is attended with little risk to the patient. I believe the open method will be used with increasing frequency in simple fractures, because due to the increase of industrial pursuits, and rapid transportation, with their hazards, fractures are far from simple in the literal use of that word.

The conservative or "closed" method of treatment entails the use of apparatus, simple in mechanical principle. However, it has been my experience when visiting large fracture wards that are not only well manned but have every mechanical facility, too often to see apparatus that is perfect in design and conception doing anything but what it should be doing, because of some trivial interference. This, occurring even under the best of conditions, makes one realize the difficulties in using apparatus that is intended to be both corrective and retentive. Unless the surgeon is willing to give sufficient personal supervision to the exacting details incident to the carrying out of the closed method, it may be that, for him at least, better results by open reduction of the fractures will be obtained. Usually the apparatus has first to reduce the fragments and then to hold them in position. After open operation and reduction the apparatus merely retains a position obtained.

About twenty years ago, a committee appointed by the British Medical Association³ spent a great deal of time tracing a number of patients who had had fractures, endeavoring to ascertain whether the best results were obtained by the closed method or by the open method. It is evident, in reviewing their report and reading between the lines, that although the

FRACTURES OF HIP, ANKLE AND ELBOW

committee was convinced that better results had been obtained by the open method, because of the danger of broadcasting to the profession in general, and thus encouraging the use of a method that in untrained and unskilled hands is potentially dangerous, they did not stress the facts really obtained. A few years later, the American Surgical Association⁹ made a similar review, but the results, as they found them, were so disappointing that they failed to publish the outcome of their inquiry; the report lies buried in the little-read transactions of the society.

In our practice in the Mayo Clinic, we hold no preference either for the closed or for the open method, but adapt the method to the fracture under consideration. If the operative open method is to be used, it should be carried out at once and not after reduction has been attempted by vigorous manipulations. We have long abandoned the view that the operative method should be used only after conservative efforts have failed. On the other hand, we are also far from the point of advising operative interference for all fractures. Since the institution of a hospital service ready to take care of fractures at any time, day or night, our fracture service has steadily grown to a considerable size for an agricultural community.

Skeletal traction is once more coming more into prominence. The work of Boehler, with his placing of small wire-like pins under local anæsthesia, and the method of Kirschner, with his special apparatus for introducing fine wires, have made possible more free use of the method. Orr for many years has treated fractures by the same principle. Steinman pins are large and tend to produce irritation at the point of contact with soft tissue. There can be no doubt that skeletal traction, properly applied, is superior to any other form of traction employed. It may be used to advantage in certain fractures of the os calcis and of the lower end of the tibia, involving the joint, and in fractures of the lower end of the humerus, when there is much comminution and involvement of articular surfaces. However, skeletal traction in unskilled hands may lead to serious infection.

In a paper of this nature it is impossible to review the many different types of fractures that could be considered profitably. Therefore I have selected fractures of the hip, the ankle and the elbow for consideration, because they are in situations where poor results are likely to lead to serious disability.

FRACTURES OF THE HIP

• Fractures of the neck of the femur, and I am speaking of the intracapsular and not of the trochanteric type, usually occur in elderly persons and indirectly cause the death of many patients. Whitman, who for many years has advocated his abduction method, has gradually convinced the profession of its merits, so that it is now more or less accepted as the standard treatment. Attempts have been made in the last few years, particularly by the American Orthopædic Association, to find out what the results are following treatment of recent intracapsular fractures of the neck of the femur.¹⁰ It is not an easy task, for many confuse the trochanteric fractures with those under consideration. The mortality rate

MELVIN S. HENDERSON

among patients with intracapsular fracture of the neck of the femur is high, regardless of what line of treatment is carried out. The group that I am reporting herewith is an unselected group of patients with intracapsular fracture of the hip, taken as they came in, regardless of age, condition, and so forth. If one were to select the cases of patients who were young enough and well enough to permit satisfactory treatment, the mortality rate would be much lower. The number of patients aged less than sixty years in this unselected group is fifteen with a mortality rate of 13.3 per cent.; the number of patients aged more than sixty years is twenty-seven with a mortality rate of 14.8 per cent. (tabulation). The mortality rate for the combined age group was 14.2 per cent. Any death which occurred during the period of treatment has been included, regardless of whether or not the patient was in hospital. One patient died of appendiceal abscess three months after the

FRACTURES OF THE NECK OF THE FEMUR

	Fifteen patients less than 60 years. Males 7; females 8	Twenty-seven patients more than 60 years. Males 9; females 18
<i>Treatment</i>		
Abduction (Whitman)....	10	14
Traction.....	1	5
Spica cast.....	2	7
Open reduction..	2	1
<i>Results</i>		
Bony union....	10 (76.9 per cent.)	13 (54.1 per cent.)
No union.....	1	7
Not known....	2	3
Died.....	2 (13.3 per cent.) One died of pneumonia after sixteen days and one of appendiceal abscess after three months	4 (14.8 per cent.) One died of shock after three days, one of pneumonia after three weeks, one of pulmonary embolism after thirty-two days, and one of uræmia after six weeks

accident; he had been sent to his home in the country for convalescence but failed to reënter the hospital before rupture of the appendix. One patient died of pulmonary embolism thirty-two days after the accident; one of shock in three days; one of uremia in six weeks; one of pneumonia in sixteen days, and one of pneumonia in three weeks. Excluding from consideration the patients who died under treatment, and basing our percentage of good results on those who survived and those concerning whom results are known, it was found that bony union was obtained in 90 per cent. of the patients aged less than sixty years and in 65 per cent. of those aged more than sixty years. On the other hand, if the patients are not divided into age groups and the patients who died are counted as failures, excluding only those concerning whom the result was unknown, the number would be thirty-seven, twenty-three (62.1 per cent.) of whom obtained bony union. If the patients who died and those who were not traced are excluded, the number would be thirty-one, and the percentage of bony union for the entire group would be 74.1. It seems fairest, however, to include the dead as failures and leave out only

FRACTURES OF HIP, ANKLE AND ELBOW

those concerning whom the end result is not known. Therefore, in this series bony union was obtained in 76.9 per cent. of patients aged less than sixty years and in 54.1 per cent. of patients aged more than sixty years. This percentage, I believe, is representative of the average results in any given group of cases in which treatment was carried out under conditions of good hospital equipment, and so forth. Campbell, with a large experience, has reported a high percentage of successes following the Whitman method. There may be isolated instances in which careful selection of cases, and so forth, may raise the percentage of successful results, but I believe that any real improvement in results will have to be obtained by some other method than those in use now.

Smith-Petersen is advocating that most patients with fracture of the hip be operated on. He inserts a metal, flanged nail and his results thus far have been most encouraging, but I think we should await further evidence from him before carrying out more or less routinely any such treatment. However, there is no reason why the elderly patient should not have the advantages of modern surgery, for it is astonishing how well the aged tolerate proper surgery. Perhaps we have been too conservative.

When a fracture of the neck of the femur is firmly impacted, union may occur without any treatment, and I have no doubt that many patients with injuries to the hip have undiscovered impacted fractures of the hip which heal promptly. Too often, however, the opposite is true; no diagnosis is made and the result from lack of treatment is non-union. Several years ago, in reviewing the cases of ununited fractures of the hip observed at the clinic, I found that of a large series not one patient had had anything approaching proper treatment. Nevertheless, we must acknowledge that in spite of the best of treatment, non-union may result. If the physician who is called on to treat a patient feels that he cannot properly carry out the necessary treatment rigidly, he should refer the patient to someone who can. Treatment according to the method of Whitman demands fixation in a cast for twelve or fourteen weeks, with the leg in abduction and the foot inverted, and although much can be done by good nursing to alleviate the discomfort of the patient, the treatment is far from a comfortable experience. Fall in blood-pressure occurs and there is danger of pulmonary embolism. We frequently whip up the circulation with thyroid extract and with a system of exercises for the arms as suggested by Walters. A troublesome convalescent problem is the stiffness of the knee; so the shorter the period of fixation of the knee the better. Far too often, the history given is that the abduction treatment was started but that the cast either broke, or that, at the insistence of the patient or his relatives, it was removed at the end of a month or six weeks. The cast should not be removed in less than three months, and no weight-bearing should be permitted in less than six months, and only then when the röntgenogram gives evidence of union. Protection may be necessary for twelve to eighteen months.

The following reports of cases will bring out some of the points that I wish to emphasize:

MELVIN S. HENDERSON

CASE I.—*Fracture of the necks of both femurs, with excellent result.* A woman, aged sixty-eight years, fell on the pavement in July, 1928, and fractured her left hip. Under anaesthesia the deformity was reduced, normal length was obtained, the leg was held out in forced abduction, the foot was rotated inwardly, so as to bring the trochanter up to a more anterior position, and a spica cast was applied which extended from the thorax to the toes on the affected side and to the knee on the other. A röntgenogram, taken four months later, gave evidence of good bony union of the neck of the femur on the left. The patient was then allowed to be up on crutches, with a high-soled shoe on the right foot to prevent weight-bearing on the left. While she was walking along the corridor, using crutches, with a nurse by her side, she slipped and fell, over against the wall, but was caught before she fell to the floor. Pain in the right hip followed, and a röntgenogram gave evidence of a crushing fracture of the portion of the neck of the femur just beneath the head with no marked displacement. The patient was put to bed and the position was maintained in a Thomas splint on the right leg for three or four weeks and then movement

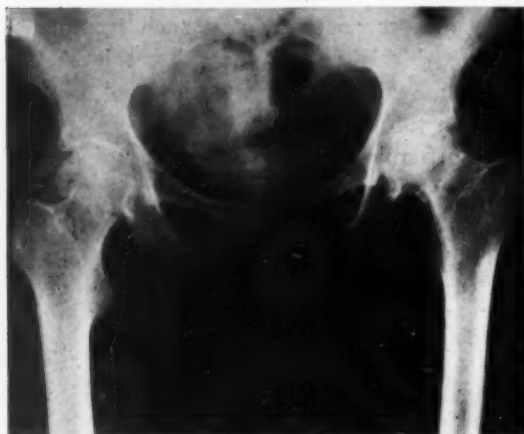


FIG. 3.—Fracture through neck of left femur firmly united. Compression fracture of subcapital portion of neck of right femur. Excellent function in both hips.



FIG. 4.—Fracture of neck of femur with firm bony union in three months.

was begun. She gained rapidly, all pain disappeared and weight-bearing was permitted on the leg within two months from the time of fracture; crutches were used, but no elevation. The patient has made full recovery and daily attends to her business as proprietor of a store; she is on her feet a great deal with no discomfort. She walks without limp or pain (Fig. 3).

Crushing fracture of the sound hip, when the patient was allowed to be up, has happened in several cases and may be an argument against prolonged use of the double spica. Prolonged fixation may cause sufficient osteoporosis to weaken the bone for weight-bearing.

CASE II.—*Fracture of the neck of the femur with rapid union in a case of pernicious anæmia and a cardiorenal syndrome.* A woman, aged fifty-five years, sustained a fracture of the neck of the left femur in February, 1916. She was treated according to the method of Whitman, as described, with an excellent result. Fig. 4 shows firm bony union after three months, the most rapid union I have ever seen following a fracture of the hip. This quick healing occurred in spite of the fact that the patient was suffering from pernicious anæmia, hypertension, and chronic nephritis. The patient lived for two years following the fracture with excellent function of the hip. She succumbed to anæmia.

FRACTURES OF HIP, ANKLE AND ELBOW

One occasionally sees, in a case of chronic nephritis, rapid healing of fractures, just why I do not know, but there seems reason to believe that there is more diffusible calcium available in the blood of a patient with nephritis than of a person with normally acting kidneys.¹²

CASE III.—*Fracture of the neck of the femur, with firm bony union but with subsequent arthritis.* A woman, aged fifty years, was treated for fracture of the neck of the femur. Firm, bony union occurred, but two years afterward she presented atrophy and roughening of the head of the femur, leading to restriction of motion (Fig. 5).

I do not know how the results in this case could have been prevented. Nourishment of the head of the femur is obtained through several channels. Santos believes that the ligamentum teres is more often concerned with the nourishment of the head than we had thought. It is a fact that impairment of nourishment of the head of the femur may result from fracture of the neck and still be no great obstacle to bony union. Santos believes that he is able, by radiographic studies, to tell, in cases of non-union, whether or not the head is viable.



FIG. 5.—Firm bony union following fracture of neck of femur but disability resulting on account of changes in head of femur.



FIG. 6.—Firm bony union seven months after reduction with the head in valgus position.

CASE IV.—*Fracture of the neck of the femur; reduction accomplished with valgus position of the head.* A woman, aged sixty-four years, sustained an intracapsular fracture of the right hip. It was reduced by the Whitman method, and it was possible, as is often the case in thin, elderly women, to overstretch the leg and produce enough lengthening so that the head should be slipped onto the neck in a valgus position. I believe that the valgus position of the head, when it is possible to obtain it, is favorable to the development of rapid and firm bony union. Fig. 6 represents the firm bony union seven months after reduction.

CASE V.—*Open operation for recent fracture of the neck of the femur and use of beef-bone peg.* A woman, aged fifty-five years, came to the clinic with a fracture of the neck of the femur of two days' duration. I attempted to reduce it by the Whitman abduction method, but there was a tendency for the lower fragment to slip up a little and the feeling of bony solidity one has when the fragments are thoroughly locked was not present. Accordingly the joint was opened and a badly comminuted fracture was found. So much of the articular surface was comminuted, and the capsule was so turned in between the fractured surfaces, that there was not more than a centimetre of bony contact between the head and the neck. I dissected out the tissue from between the fragments and placed a beef-bone peg through the trochanter and neck into the head, and held the leg in abduction in a plaster-of-Paris case.

MELVIN S. HENDERSON

Figure 7 represents the excellent result two and a half years after the operation; the beef-bone peg is still in position and shows very little evidence of absorption.

NON-UNION OF THE NECK OF THE FEMUR

Because of its relative frequency I shall consider briefly those patients whose hips fail to unite and who have definite non-union. They are disabled because of lack of skeletal support; weight-bearing is carried on by ligamentous and muscular support. Pain is variable, but may be the most distressing symptom. The problem presented to the surgeon is to furnish skeletal support with maximal motion. Following the primary wave of enthusiasm for the bone-grafting treatment of ununited fracture of the neck of the femur, there was a swing of the pendulum toward the so-called reconstruction operations. This was natural, because an operation for non-union of the hip, wherein a bone graft is used, is difficult and tedious, and



FIG. 7.—Recent fracture reduced and held by beef-bone peg. Röntgenogram two and a half years later. Persistence of the beef-bone peg may be noted.



FIG. 8.—Condition eight years after open operation and insertion of fibula as a graft for non-union of two years' duration. Persistence of bone graft may be noted. Excellent function.

calls for all the skill the surgeon possesses. The risk incident to the operation, and the long confinement afterward, are factors that cannot be disregarded. If the operation is a failure the patient has made a big sacrifice, and such a result is a keen disappointment to him and to his surgeon. Series of cases have been recorded in which 75 per cent. or more good results have followed the use of a bone graft for non-union of the neck of the femur; therefore it is established that in properly selected cases good results may be obtained.⁵ Albee recently reported a series with over 90 per cent. successes.

The patient should be preferably under fifty-five years of age, in good health, and of the vigorous type. A meticulous operative technic must be developed, and good access to the fractured surfaces must be obtained, so that freshening and fitting of them may be carefully carried out, aided by visual inspection. A good-sized graft should then be taken, either a full segment of the fibula or a piece from the tibia, and this should be put in the channel prepared for it, through the trochanter, through the remnant of the neck, and up into the head. If the graft is taken from the upper end of

FRACTURES OF HIP, ANKLE AND ELBOW

the tibia, curettefuls of the spongy bone near the epiphyseal line should be removed and packed as a sort of cement around the graft to fill in any gap that might exist between the freshened head and the freshened neck. Bone taken from near the epiphyseal line is rich in bone-forming properties.

If the patient is too old and is not thought fit for such a radical procedure as grafting of bone, or if too much atrophy of the head and neck is present, the reconstruction operation of Whitman gives good functional

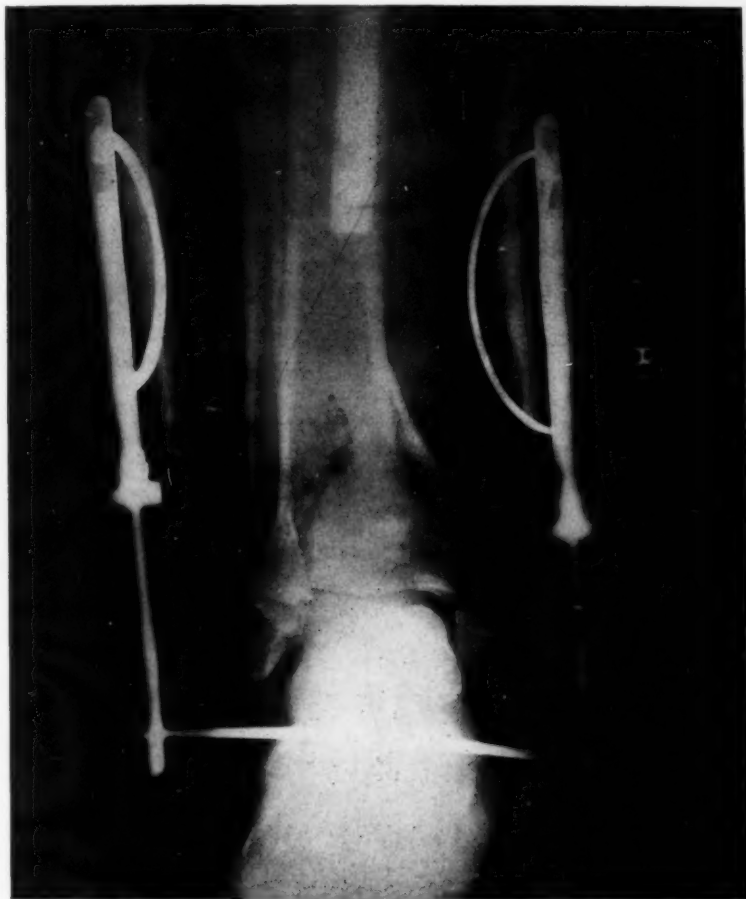


FIG. 9.—Skeletal traction for comminuted fracture of lower end of tibia. Side rods with crutched ends to force down the pin through the os calcis (Gillette).

results. Also, when the hip-joint has been opened, difficulties may be encountered which will prevent satisfactory freshening and fitting of the head to the neck of the femur. These difficulties may be impossible to surmount within a time commensurate with safety. In these cases I believe that the Whitman reconstruction operation should be carried out. Viability of the head often has been mentioned as being of extreme importance. It is difficult to tell when the head of the femur is dead for even when it is living it may be impossible to demonstrate bleeding by freshening it. Not infre-

quently I have been agreeably surprised to find that the head of a femur, which I had thought was dead and of little use, would function properly after a bone-grafting operation had been performed and to find that the head did not show late changes on resumption of weight-bearing. This is illustrated by the case of a man, aged fifty-eight years, who suffered from non-union at the hip for two years. The fibula was used as a graft, and Fig. 8 shows the condition eight years after operation and demonstrates persistence of the bone graft over a period of eight years. The patient has full function of the hip, with no limp. This case furnishes some clinical evidence to refute the statement that bone grafts are absorbed and do not persist and live in their original form.

FRACTURES OF THE ANKLE-JOINT

Fractures of the ankle-joint may be particularly difficult to treat and may lead to great disability. This is illustrated by the case of a young man

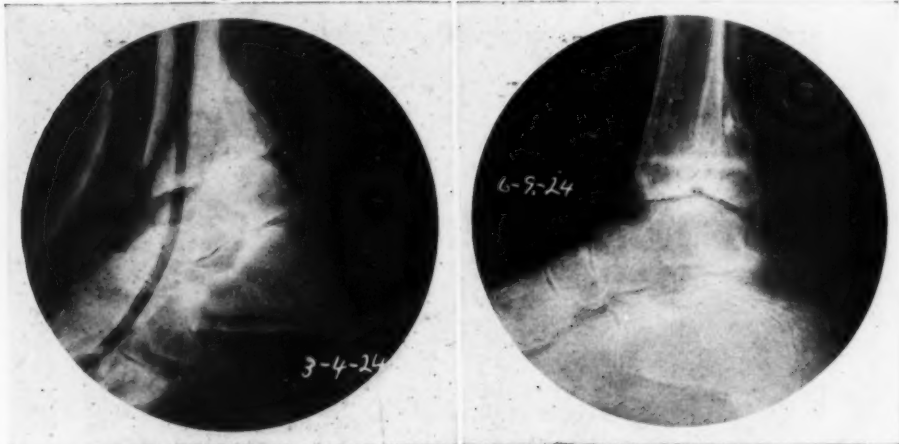


FIG. 10.—Fracture of ankle with posterior displacement of astragalus. The posterior fragment is so large that the convex surface of the astragalus finds inadequate resting place in the remaining concave arch in the tibia.

FIG. 11.—Ankle shown in Fig. 10, four months after reduction. The beef-bone screw may be noted.

who had a compound, comminuted fracture of the lower end of the tibia. Although the joint itself was not opened there was much excoriation of skin, with considerable subcutaneous hæmorrhage and œdema. A pin was placed through the os calcis and the apparatus described by Gillette was used (Fig. 9). Rods, crutched on the ends to fit over the pin, the opposite end fitting into cannulas with set screws, were fitted into the case. Force was exerted by screwing up the set screws, thus forcing the pin, and hence the foot, downward. For such procedures the case must include the foot and leg and must extend well up onto the thigh, with the knee flexed. A good deal of padding must be placed on the flexor surface of the thigh so that pressure will not cause necrosis. This patient was very comfortable, good line was maintained, and although the comminution produced some broadening of the ankle the final result was excellent.

FRACTURES OF HIP, ANKLE AND ELBOW

Pott's fracture, with tearing of the internal lateral ligament or chipping off of a portion of the internal malleolus, and fracture of the fibula 5 or 8 centimetres above the malleolus is familiar to all. There is no posterior displacement of the foot, and the malposition is merely one of valgus. Good results are readily obtained if the deformity is corrected, and the extremity is put up in a plaster-of-Paris case extending from the knee to the toe, with the foot in slight inversion so as to push the astragalus back into its normal position and if the concave upper surface of the astragalus as shown in an antero-posterior röntgenogram is made to fit into the slightly convex surface of the tibia.

Fracture in the same region, with posterior displacement of the foot, known as Cotton's fracture, is more formidable. There is fracture of the internal malleolus, or tearing of the internal lateral ligament, and fracture of the fibula. However, in addition there is a longitudinal, oftentimes spiral, fracture which extends upward for several centimetres, through the articular surface of the tibia into the shaft, with posterior and upward displacement of the posterior fragment of the tibia. This permits the astragalus, and thus the whole foot, to slip backward. Reduction and maintenance of correction of this type of fracture is comparatively easy, if the posterior fragment of the tibia is small. The röntgenogram made from the lateral aspect should demonstrate that the normally convex surface of the astragalus has a sufficient resting place in the concave surface of the tibia to prevent it from slipping backward after reduction. If, however, the line of fracture is sufficiently far forward so that this resting place cannot be secured, then it is exceedingly difficult to hold the foot forward in the proper position because the upward pull of the muscles on the foot will pull the astragalus against the articular surface



FIG. 12.—Same ankle as shown in Figs. 10 and 11 four years later. Note entire absorption of beef-bone screw.

comparatively easy, if the posterior fragment of the tibia is small. The röntgenogram made from the lateral aspect should demonstrate that the normally convex surface of the astragalus has a sufficient resting place in the concave surface of the tibia to prevent it from slipping backward after reduction. If, however, the line of fracture is sufficiently far forward so that this resting place cannot be secured, then it is exceedingly difficult to hold the foot forward in the proper position because the upward pull of the muscles on the foot will pull the astragalus against the articular surface

of the tibia and displace the tibial fragment again posteriorly. Division of the tendo achillis may help, but if that fails it is necessary to perform an open operation and by some means to fix the posterior fragment of the tibia to the anterior fragment of the tibia, thus restoring the arch for the reception of the astragalus.

This is illustrated by the case of a woman who sustained this type of fracture. Fig. 10 shows the foot as it was held in the cast after closed reduction, but the deformity is not reduced. Fig. 11 shows the posterior fragment of the tibia restored to its normal position and held in place by a beef-bone screw, and the astragalus staying in position. The patient obtained an excellent result (Fig. 12).

When weight-bearing is permitted following a fracture of the ankle, precautions must be taken to see that the foot is not allowed to assume a valgus position. By raising the inner side of the sole and heel the foot can be held in slight varus. This is especially necessary if patients are heavy.

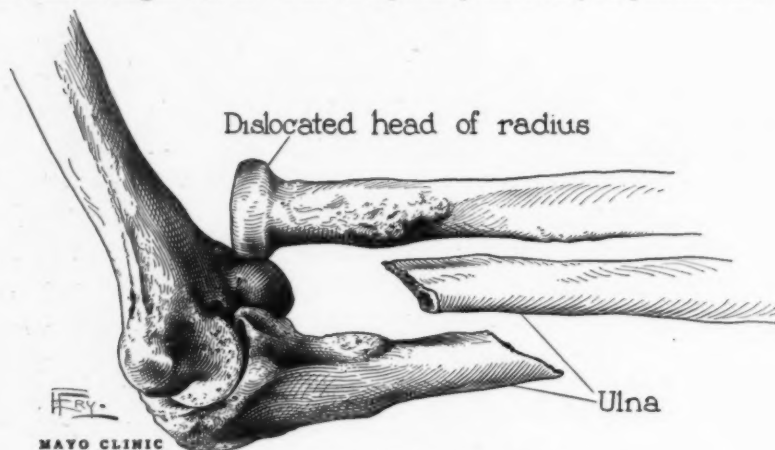


FIG. 13.—Fracture of ulna with dislocated head of radius.

FRACTURES OF THE ELBOW

Fractures of the elbow, common in childhood, are in reality usually fractures of the lower end of the humerus. That is, they constitute either an epiphyseal separation, or a fracture just above the epiphysis, with posterior displacement of the lower fragment and anterior displacement of the upper fragment. If they are left unreduced, marked limitation of motion results; there is inability to flex the elbow to a useful angle and also lack of extension. Fractures of the head of the radius may result in marked limitation of pronation and supination. It is surprising how much comminution of the radial head may be present and yet show but little in the röntgenograms. Therefore, if there is any reason to believe that a fracture of the head of the radius is badly comminuted, early excision of the head is indicated. Early excision results in excellent function, whereas late excision is often disappointing. A disabling fracture, more common in adults, that involves

FRACTURES OF HIP, ANKLE AND ELBOW

the elbow-joint, occurs through the upper third of the ulna, with secondary dislocation of the head of the radius (Fig. 13). Such a fracture dislocation is best treated by an open operation. The ulna should be held in place, if necessary, by some form of internal splintage, and the elbow should be flexed somewhat more than a right angle with the hand in full supination. When a fracture of the lower end of the humerus is seen early, before swelling develops, it usually can be reduced and held in good position if the elbow is acutely flexed and is held either by a plaster-of-Paris case or by a strip of adhesive tape placed around the forearm and arm. When these fractures are seen late, after callus has formed (Fig. 14), there is nothing to do but open the joint by a posterior incision, correct the alignment, and hold the fragments in position either by the acutely flexed position or by aid of a beef-bone screw (Fig. 15). Fig. 16 shows an excellent result three years after operation in a case so treated. In the adult, particularly if the fracture



FIG. 14.—Supracondylar fracture of humerus before open reduction.

is badly comminuted and the comminution involves the articular surface, it is sometimes impossible by manipulation, or even by open operation, to restore the fragments to anything like normal position. In such cases, skeletal traction, applied on a humeral splint, by putting a wire through the olecranon process, gives as good control as can be obtained. Swelling is the great hindrance in fractures of the elbow, and may compel one to abandon a good position to prevent the development of ischæmic paralysis.

Ischæmic paralysis of the forearm is seen far too often. It may and does occur in the lower extremity, but the same degree of disability does not ensue. Following reduction in fractures of the elbow, an acute, flexed position of the elbow is necessary in most cases and it is this position which may lead to sufficient pressure on the superficial veins of the forearm to cause venous stasis. As the swelling increases and stasis further occurs, ischæmic paralysis rapidly develops, for it takes only a comparatively short



FIG. 15.—Same elbow as shown in Fig. 14 after reduction held by beef-bone screw.

time to bring on ischaemia. Severe pain, particularly if it is associated with swelling and discoloration, should receive prompt attention. Any constricting dressing should be promptly loosened, and position should be disregarded



FIG. 16.—Seven months after reduction full function of elbow. Same elbow as shown in Figs. 14 and 15.

if necessary to restore circulation. Ischaemic paralysis, however, may occur without any constricting band or bandage having been applied; hæmorrhage within the muscular compartments may be the cause. If such is the case,

FRACTURES OF HIP, ANKLE AND ELBOW

multiple small incisions should be made without delay to allow the encapsulated blood to escape. It is most distressing to see a child, röntgenograms of whose arm give evidence of excellent reduction of a fracture of the elbow and normal position of bony parts, but whose hand and forearm are hopelessly crippled by ischaemic paralysis. When paralysis has developed, treatment is uncertain, long and tedious, and often unsatisfactory. The Robert Jones method is most used and is carried out by a series of splints which gradually stretch the fingers from flexion into extension and then the wrist from flexion into extension. Various surgical measures, such as removal of bone and lengthening of tendon, have been used in resistant cases with indifferent results. Meyerding has reviewed and reported our cases. The prognosis depends entirely on the amount of muscle that has been permanently injured. Range of motion is determined by the elasticity and contractility possible in the remaining muscle. Muscle once destroyed is never fully replaced by like tissue, but by fibrous tissue.

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MALUNION OF FRACTURES OF THE FEMUR *

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SCUDDER¹ states a good recovery after a fracture of the femur should show: (1) Correct alignment; (2) full length; and (3) functional use of all joints.

The Committee of the American Surgical Association² puts the requisites for satisfactory results as follows: (1) Firm bony union; (2) the long axis of the lower fragment is either directly continuous with that of the upper fragment, or is on nearly parallel lines, thus preventing angular deformity; (3) the anterior surface of the lower fragment maintains nearly its normal relation to the plane of the upper fragment, thus preventing undue deviation of the foot from its normal position; (4) the length of the limb is exactly equal to its fellow, or the amount of shortening falls within the limits found to exist in 90 per cent. of healthy limbs: namely, from one-eighth to one inch; (5) lameness, if present, is not due to more than one inch shortening; (6) the conditions attending the treatment prevent other results from those obtained.

Variations from these standards may be grouped as follows: (1) Non-union; (2) bowing or angulation in any direction; (3) shortening; (4) rotation; (5) instability of joints; (6) displacement of fragments; and (7) stiffness of joints.

Definition of Malunion—With the exception of non-union, any one of these groups of defects may be present to a slight degree and still a good functioning limb obtained. If, however, in a given case, union of the fragments takes place in such a manner as to seriously interfere with function, then we may call this a case of malunion.

Jones³ states that malunion is more common in the femur than in any other bone in the body. He also states that malunion can always be prevented. To his latter statement we must take exception. Nearly all cases are preventable, but some are not.

For a study of malunion I have been able to assemble thirty-two cases (Table I) seen by my colleagues and myself in Bellevue Hospital, of New York, and the Hospital for Ruptured and Crippled. Most of these cases were admitted already with malunion, some of them developed under our care. (See Table I.)

Causes of Malunion.—The causes of malunion of the femur may be grouped as follows:

1. Errors in the initial treatment, or in reduction of the fracture. Case

* Read before the Section of Surgery of the New York Academy of Medicine, May 2, 1930.

MALUNION OF FRACTURES OF FEMUR

TABLE I

No.	Age	Site	Original Treatment	Cause Malunion	Type Malunion	Ins. Short
S. I. 41	7 wks.	Mid. $\frac{1}{2}$	Plaster parts, foot by ear.	Mother removed plaster parts case.	Anterior lateral bowing marked.	1 $\frac{1}{2}$ "
D. K. 2	41	Mid. $\frac{1}{2}$	Closed reduction, ether, plaster parts for 8 weeks and no union—interposed muscle. 2. Bone inlay and plaster parts spica.	Slipped in plaster parts and hematoma after bone inlay.	Overlapping, considerable callus; moderate angulation.	1 $\frac{1}{2}$ "
C. S. 3	12	Mid. $\frac{1}{2}$	Plaster parts and traction.	Slipped in plaster parts.	Anterior lateral angulation. Only 20° flexion in knee.	1 $\frac{3}{4}$ "
D. D. 4	45	Low $\frac{1}{2}$	Plaster parts 3 $\frac{1}{2}$ weeks; then baking and massage. Supracondylar fracture.	Immobilized only 3 $\frac{1}{2}$ weeks.	Anterior medial angulation. Relaxation ligaments knee.	2"
B. C. 5	19	Mid. $\frac{1}{2}$	Tongs twice, then plaster parts.	Tongs slipped.	Marked anterior bowing; large amount callus.	2"
R. W. 6	23	Mid. $\frac{1}{4}$	Suspension 4 days; plaster parts 5 weeks; open reduction and Lane plate, up in wheelchair 6 weeks; slipped and 3rd plaster parts 7 weeks; bowing; osteotomy and plaster parts 4 weeks. Crutches and cane—16 months.	See treatment of patient. Position not maintained till union took place.	Marked lateral bowing. Large amount callus.	2"
A. S. 7	29	Low $\frac{1}{4}$	Traction—10 weeks.	Bowing after traction released?	Marked lateral bowing cavus of foot. Marked limitation rotation.	3 $\frac{1}{4}$ "
A. S. 8	28	Mid. $\frac{1}{2}$	Traction—duration not known.	? Traction removed too soon and overweight. Lung abscess developed soon after accident.	Double fracture, marked anterior lateral bowing. Equinus foot.	2"
A. S. 9	47	Mid. $\frac{1}{2}$ and Upp.	Plaster parts spica.	Never reduced.	Marked limitation motion knee and hip; overlapping.	3"
D. S. 10	20	Mid. $\frac{1}{4}$	(1) 3 days wooden splint. (2) Suspension and traction 4 days. (3) 8th day after injury manual reduction and plaster parts. (4) Plaster parts removed; Thomas splint and traction 8 weeks.	Reduction never maintained, frequent change treatment.	Backward bowing and overriding, excessive callus, only slight flexion of knee.	2 $\frac{1}{4}$ "
H. S. 11	25	Mid. $\frac{1}{4}$	Plaster parts 3 months.	Slipped in case.	Displacement of fragments, knee almost stiff. Lateral angulation. Foot almost stiff.	2"
H. C. 12	22	Mid. $\frac{1}{2}$	Wooden splints.	Never properly reduced.	Overriding, marked callus present.	3"
S. W. 13	59	Intra-trochanteric	Plaster parts 6 weeks. Baking and massage 4 weeks. Closed reduction not satisfactory. Open operation followed by plaster parts, bed sore; fragment slipped in plaster.	Primarily removing plaster parts too soon, then slipped in final plaster spica.	Marked excess of callus, coxa vara.	1 $\frac{1}{2}$ "

TABLE I (Continued)

No.	Age	Site	Original Treatment	Cause Malunion	Type Malunion	Ins. Short
14 A.O.	35	Mid. $\frac{1}{4}$ Com- pound	Tong traction, after debridement.	Compounding, osteomyelitis.	Overlapping, osteomyelitis, displacement.	3"
15 J.G.	52	Neck Rt.	Few days traction. Plaster paris 3 months, bone graft. Two subsequent hip operations, nature not known.	Changing treatments. Improper position in casts following operations.	Coxa vara. Edema leg and foot. Excessive callus, marked adduction hip.	?
16 W.H.	23	Low $\frac{1}{3}$	Tong traction few days, resting in bed, then crutches.	Tongs slipped. Patient refused re-application.	Overlapping, excessive callus.	3½"
17 M.L.	15	Mid. and Low $\frac{1}{3}$	"Australian" traction 1 month.	Traction treatment too short.	Backward displacement of lower fragment.	1"
18 W.K.	57	Neck Left	Psychosis 30 days; slide splint; ether reduction and plaster spica which was removed in 5 weeks.	Delay in initial treatment—psychosis 30 days. Spica removed too soon.	Coxa vara. Edema leg three years afterwards.	2"
19 J.W.	14	Mid.	Skin traction. Irritation skin. Then no treatment.	Traction removed too soon when skin broke down—then no treatment.	Overriding and lateral angulation, excessive callus.	2"
20 M.R.	46	Mid. $\frac{1}{3}$	Skin traction; non-union; sliding bone graft held with chromic catgut and plaster paris.	Cast cut too soon, slipped.	Overriding; angulation.	2½"
21 L.B.	60	Petro- chanteric	No treatment 3 days, then plaster spica under spinal anaesthesia.	Slipped in case.	50 per cent. limitation flexion hip. Marked thickening about great trochanter. Marked limitation abduction and rotation leg.	½"
22 P.D.	16½	Mid. $\frac{1}{3}$	Skin traction 14 days, then plaster paris.	Changed treatment, slipped in case.	Overlapping.	1¼"
23 E.K.	50	Upp. $\frac{1}{3}$	Skin traction for 2 days. Tongs slipped twice, then case applied.	Pagets disease, blood calcium 14 mgm. Tongs slipped. Slipped in case.	Marked outward displacement of upper fragment; overriding.	?
24 M.H.	54	Neck Left	Plaster paris spica 3 months.	Absorption neck.	Absorption of neck, external rotation solid union.	1¼"
25 B.M.	38	A.id. $\frac{1}{3}$	Tongs 8 weeks; skin traction 30 days, case.	Slipped while in skin traction.	Displacement, overlapping, knee almost stiff.	1½"
26 G.H.	55	Mid. and Low $\frac{1}{3}$	"Australian" traction 1 month. Tongs 11 days but wounds suppurated and tongs removed and then no treatment.	Suppurative tong wounds. Slipped when tongs were removed.	Stiff knee.	2"
27 M.G.	53	Low and Mid. $\frac{1}{3}$	Tongs 17 days; skin traction 5 weeks; Hennequin band about ankle 2 weeks, Thomas ambulatory splint.	Tongs slipped.	Angulation and overriding, marked.	2"

MALUNION OF FRACTURES OF FEMUR

TABLE I (Continued)

No.	Age	Site	Original Treatment	Cause Malunion	Type Malunion	Ins. Short
28 L.P.	16	Mid. $\frac{1}{3}$	Adhesive traction 7 weeks, then crutches.	Treatment discontinued too soon.	Marked angulation.	1½"
29 T.T.	36	Upp. and Mid. $\frac{1}{3}$	Tongs 1 month. Removed. Infected, skin traction 6 weeks.	Infected tongs.	Overriding and angulation.	1½"
30 R.S.	22	Mid. $\frac{1}{3}$	No treatment 1 week because of shock, plaster paris spica 6 weeks. Fractured skull.	Delay in initial treatment. Slipping in case.	Bowing and overriding.	3"
31 M.L.	19	Mid. $\frac{1}{3}$	Skeletal traction 9 weeks. Plaster 3 weeks, then Thomas ambulatory splint and home.	Patient did not wear ambulatory brace.	Angulation. Excessive callus.	3¼"
32	15		None.	Pathological fracture, at first not treated. Not diagnosed.	Marked coxa vara and outward bowing.	

II (Table I) illustrates this group. There was interposed soft parts (muscle) which the surgeon failed to recognize for a period of eight weeks, open operation was then done, the fragments slipped in the plaster case, and overlapping, angulation and one and one-half inches shortening was the final result. In another case (Case XII, Table I), the extremity was immobilized in wooden splints, no attempt being made to reduce the fracture (inconceivable these modern days). Overriding and three inches shortening was the final result.

2. Delay in initiating treatment. This may be the fault of the surgeon or the patient, or to some associated disease or injury. Case XVIII (Table I) developed a psychosis and delayed proper treatment thirty days. Coxa vara and three inches shortening was the final result. Another case (Case XXX, Table I) was in shock one week and had a severe fracture of the skull which prevented an anaesthesia and proper reduction. Bowing and overriding three inches was the final result. Cases of alcoholism and marked physical weakness belong to this group.

3. Failure to maintain proper position of the fragments till union is solid. This may be the fault of the surgeon or the patient or to some associated serious disease or injury. This is by far the largest of these groups and is nearly always the fault of the surgeon. As one reads over the history of these cases of malunion one gets the impression that the surgeon who treated the original injury was monkeying around with the case, shifting from one form of treatment to the other, unaware of the power of the great thigh muscles, ignorant of the time it takes callus to solidify, unskilled in the application and use of skeletal traction, forgetful of the fact that the thigh supports the weight of the body in locomotion, unaware that soft callus will bow when not protected by splints.

Cases illustrating these facts are too numerous to mention. Inspection of Table I is conclusive: "slipped in plaster," "tongs slipped," "suspension four days and then plaster five weeks," "traction removed too soon," "bowing after traction," "bowing after loosening of Lane plate"—all these are common remarks as one reviews the causes of malunion. Responsibility, however, in one case (Case XXXI, Table I) we will have to place on the patient. He went home wearing a Thomas ambulatory splint. He took it off at once and never again put it on. Union was not quite solid and he returned to the hospital a few weeks later with angulation and three and one-quarter inches shortening.

4. Infection at site of fracture or other parts of the extremity. This may be due to compounding, the compounding being direct or brought about by extensive soft part damage and later sloughing, or it may be due to infection following open reduction of the fracture. It is impossible to prevent infection in a goodly number of compound fractures, but infection after open reduction must be charged to the surgeon. Large haematomas occurring after open reduction may be regarded as mild infections, since they heal usually by secondary intention and frequently become secondarily infected,

MALUNION OF FRACTURES OF FEMUR

or cause liquefaction of tissues and bone absorption. Tong or skeletal traction wounds may become infected. This we blame on the surgeon. We have seen one case of extensive, severe cellulitis of the skin where skin traction was used. The scarring was so extensive from this infection that serious disability resulted. Such an infection is also chargeable to the surgeon. The skin should have been shaved, washed, sterilized, and the adhesive or mole skin flamed.

In this group belong the following cases: (1) Case XIV (Table I), a compound injury, with osteomyelitis and three inches of overlapping resulting; (2) Case XIX (Table I) traction was removed when "skin broke down," and angulation and two inches shortening resulted; (3) Case XXIX (Table I) "infected tongs," overriding of one and five-eighths inches with angulation.

5. Absorption of the neck. Most of these cases result in non-union, or fibrous union, though some finally get bony union. It is not preventable. It is discouraging. It is slow in asserting itself. We had two such cases (Cases XVIII and XXIV, Table I). The patients apparently got bony union after absorption of neck.

6. Pathological fractures may unite in a way which is not preventable, but, to quote B. L. Coley⁴ "displacement is greatly hampered by the presence of the tumor tissue about the site of fracture, so that marked overriding is unusual." Angulation in such cases is usually due to lack of or improper splinting, as in one case of Dr. B. L. Coley's, Case XXXII (Table I), a boy with a pathological fracture which was, before being brought to Doctor Coley, undiagnosed and untreated for several months, marked angulation and shortening being the result.

Malunion of fractures may occur in osteomyelitis, fragilitas ossium, bone cysts (most common), metastatic neoplasms, syphilitic bones, rachitis, *etc.*

7. Fractures involving the epiphysis in children may unite and grow in any direction.

8. An unnoticed fracture, particularly in the aged. These are more common about the neck of the femur. The patient may start limping or merely complain of pain at the hip or knee. Meantime, the fracture heals in a position of coxa vara or fails to heal, absorbs and non-union occurs.

9. Excessive callus. We have seen two cases in which it seemed the overgrowth of callus was largely responsible for the loss of function present. Callus also frequently contributes to loss of function, along with angulation, overriding and other deformities. Case XV (Table I) was such a case. The overgrowth of callus prevented abduction of the limb, for the broadened great trochanter impinged on the ilium when abduction was attempted. This patient had had three previous operations about the hip and hence much stimulation for bone overgrowth. It is probable also that the abduction deformity could have been prevented, had the limb been put up after these operations in more abduction. In seven of the cases operated upon the surgeon mentioned in his findings "excess callus." It seems nature throws

out enormous amounts of callus in an attempt to repair the displaced fragments.

In order that responsibility may be definitely placed we may put these causes of malunion into two groups:

A. *Preventable Causes of Malunion*.—This group makes up 80 per cent. of the causes of malunion in the series I studied. (See Table I.)

(1) Failure to recognize interposed tissue. (2) Failure to secure satisfactory reduction. (3) Delaying, in an uncomplicated case, early reduction. (4) Failure, in an uncomplicated case, to maintain proper position of fragments till union is solid: (a) slipping in case; (b) tongs slipping; (c) shifting from one form of treatment to another; (d) bowing after traction or after splints removed; (e) not using Thomas ambulatory splint in many

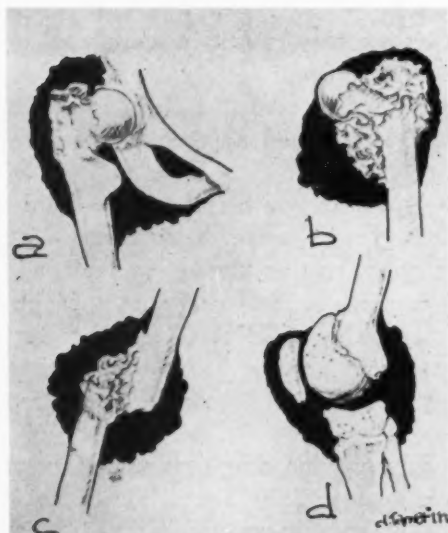


PLATE I.—Illustrating Types of Deformity.*
A. (Case XXIV, Table I) Coxa Vara, absorption of the neck, rotation outward as shown by prominence of lesser trochanter. B. (Case XIII, Table I) Marked excess of callus. C. (Case XI, Table I) Overlapping and displacement backwards of upper fragment. D. Displacement forward and upward of lower fragment.

* Drawings from actual cases.

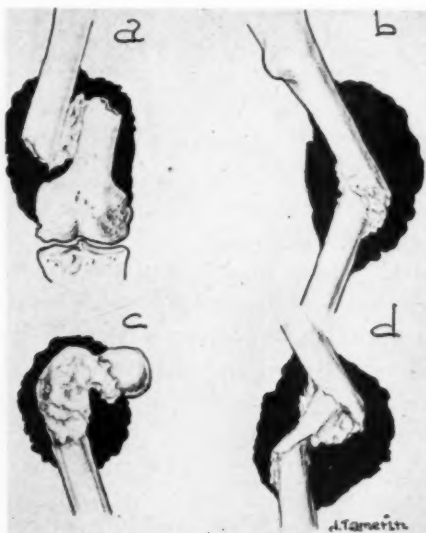


PLATE II.—Types of Deformities.* A. (Case XVI, Table I) marked overlapping. B. (Case XXXI, Table I) marked angulation. C. (Case XXXII, Table I) angulation in healed pathological fracture, osteitis fibrosa cystica. D. (Case VIII, Table I) double fracture with angulation.

* Drawings from actual cases.

cases. (5) Infection: (a) in most compound fractures; (b) in all open reductions; (c) in all tong or pin wounds; (d) of skin in skin traction; (e) hæmatomas occurring after open reduction (frequently amount to mild infections).

B. *Non-preventable causes of malunion*.—This group constituted 20 per cent. of the cases. (See Table I.)

(1) Delay in initiating treatment due to associated disease or injuries. (2) Failure to maintain proper position of the fragments is sometimes due to lack of coöperation of patient, sometimes due to associated disease or injury. (3) Infection in some compound fractures. (4) Absorption of

MALUNION OF FRACTURES OF FEMUR

neck of femur. (5) Certain epiphyseal fractures. (6) Fractured hip in which patient does not seek treatment for some time. (7) Excessive callus.

Types of Deformities (see Plates I and II).—1. Overlapping, overriding (Table I, Cases XI, XII, XXII, XXVI).

2. Angulation or bowing in any direction (Table I, Cases I, II, III, IV, V, VI, XXXI).

3. Rotation (usually lower fragment) recorded once in thirty-three cases (Table I, Case XXIV) but was probably present in some cases and not noted on chart.

4. Excessive callus (Table I, Cases XV, XIII) more commonly associated with other types.

5. Hip, or proximal end femur: (a) loss neck femur due to absorption (Case XXIV, Table I); (b) coxa vara (Table I, Cases XXI, XXXII).

6. Knee-joint, or distal end of femur: (a) fracture into joint, one or more fragments displaced; (b) entire epiphysis displaced.

7. Displacement of shaft fragments—wide separation (Table I, Cases XIV, XXV).

8. Combinations of above types (Table I, Cases II, X, XI, XIV, XV, XVI, XVII, XIX, XXIII, XXV, XXVII, XXIX, XXX).

Classical Operations Performed for These Various Types of Malunion (see Table II).—1. Open osteotomy: (a) this may be done by various methods as devised by Jones,⁵ Whitman⁶ and others. Following the operation the limb is straightened, plaster-of-Paris spica is applied, or some form of traction. Cases so treated were IV, V, VI, VII, VIII, IX, XXXII (Table II). (b) Closed osteotomy followed by plaster. In children or in adults where union is not strong or where there is marked atrophy, osteoporosis, of femur (Cases I and V, Table II). The osteotomy is done largely to overcome bowing or angulation thereby securing better alignment.

2. Large exposure, separate fragments, may remove some of the callus present, reappose fragments, plate, bone graft, or apply skeletal traction. Cases so treated were III, IX, X, XII, XVI, XIX, XXX, XXXI (Table II). The idea in this group of cases is usually to increase the length of the extremity as well as correct the alignment. A procedure which offers much in this direction is that of Dr. LeRoy C. Abbott, of St. Louis. He has lengthened to date some fifty tibias and some twenty femurs. His results in the leg have been remarkable, an average of two inches in length being gained. In the femur 50 per cent. good results have been obtained. Recently at the Academy of Medicine, New York, Doctor Abbott showed moving pictures of two cases where a gain of four inches in length had been obtained in an extremity, two inches by lengthening the femur and two inches by lengthening the tibia. All of Abbott's cases have been in children sixteen years of age or younger, and most of them in paralytic cases, but his principles of lengthening are according to the best surgical technic and will undoubtedly in the future be given a thorough trial in certain cases of malunion of the femur resulting from trauma.

RUSSEL H. PATTERSON

TABLE II
Cases of malunion operated upon

No.	Age	Type	Treatment	Result
1 S.W.	7 wks.	Mid $\frac{1}{2}$ Anterior lateral angulation. $1\frac{1}{2}$ " shortening.	Closed reduction and plaster paris spica.	?
3 C.S.	12	Mid $\frac{1}{2}$ anterior lateral angulation. $1\frac{3}{4}$ " shortening, only 20° flexion in knee.	Open operation, separation fragments, excessive callus removed, plated. Plate removed 2½ months.	Slight lateral bowing, slight limitation flexion knee.
4 D.D.	45	Lower $\frac{1}{2}$ Anterior medial angulation marked. 2" shortening, relaxed ligaments of knee.	Osteotomy— $\frac{1}{4}$ " wedge, plaster paris.	Femur in line, brace for relaxation about knee. Knee flexion 140°. Patient well satisfied. Post-operative pleurisy.
5 B.G.	19	Mid $\frac{1}{2}$ Marked anterior bowing, excess callus	Forcibly broken, plaster paris.	Flexion in knee possible to 90°.
6 R.W.	23	Up and Mid $\frac{1}{2}$ Marked bowing lateral, excess callus, 2" shortening.	$1\frac{1}{2}$ " wedge-osteotomy, plaster paris. Hematoma in wound removed 11 days post-operative.	Discharge 2½ months post-op. with steel and leather spica, femur in line.
7 A.Sr.	29	Lower $\frac{1}{2}$ Marked lateral bowing. $3\frac{1}{4}$ " shortening.	Wedge-osteotomy, plated, plaster paris.	Leg straight. "Improved."
8 A.Sy.	28	Mid $\frac{1}{2}$ Double fracture with marked lateral and anterior bowing. 2" shortening.	Simple osteotomy and plaster paris. Spinal anaesthesia.	Stable extremity, but flexion at knee only to 25°.
9 A.Sa.	47	Mid $\frac{1}{2}$ Overriding 3" shortening. Knee almost stiff.	Osteotomy, fragments separated, freshened ends, traction with Steinmann pin in femur.	Marked stiffness in knee. 2 years later Bennett operation on knee, but marked stiffness in knee remained.
10 D.S.	20	Mid $\frac{1}{2}$ Back bowing overriding, excessive callus $2\frac{1}{4}$ " shortening.	Open operation, excessive callus removed, bones separated, contraction of tissue and formation of bone prevented reduction, bones then locked and held with bone screw.	Died—four days post-operative. Gas Bacillus Infection.
12 H.G.	22	Mid $\frac{1}{2}$ Overriding, marked amount of callus.	Extremely difficult open operation, excessive callus removed, tongs, fragments slipped, hematoma of wound, absorption some bone.	No improvement. One year out of boy's life.
15 J.G.	52	Intertrochanteric. Marked excessive callus, coxa vara, adduction hip, arthritis knee.	Simple osteotomy at level lesser trochanter.	Adduction deformity corrected. Motion in hip improved. Arthritis in knee excited and caused great disability.
13 S.W.	23	Low $\frac{1}{2}$ Overlapping $3\frac{1}{2}$ " , excessive callus.	Anterior incision, separation fragments, excision callus, plating, case. Very difficult operation.	Died. Shock. Ten hours post-operative.
19 J.W.	14	Mid $\frac{1}{2}$ Overlapping 2" angulation lateral, considerable callus.	Open operation, callus excised, Lane plate, plaster paris spica. Post-operative hematoma and slight skin infection.	Some stiffness in knee.
30 R.S.	22	Mid $\frac{1}{2}$ Bowling and overriding 3".	Open operation, separation of fragments, tongs 45 days, skin traction 38 days. Fragments never gotten end to end, even with 65 pounds traction.	After about two years' delayed union there was malunion with same conditions as before treatment.
31 M.L.	19	Mid $\frac{1}{2}$ angulation, $3\frac{1}{4}$ " shortening, excessive callus.	Open osteotomy, removal of considerable callus. Steinmann pin in os calcis incorporated in plaster paris spica.	Only six weeks since operation. X-rays show overlapping of 1" and callus not solid.
32	15	Marked coxa vara and outward bowing. Osteitis fibrosa cystica	Wedge osteotomy and plaster spica.	Knee flexion to 90 degrees. Hip had only slight motion. Brace to protect pathological bone.

MALUNION OF FRACTURES OF FEMUR

3. Resection of knee when fracture is about knee-joint, with fragments greatly displaced—rarely an arthroplasty.

4. Reconstruction operation (osteotomy usually done but this operation occasionally indicated) about hip when there is malunion about head or neck of femur with ankylosis of hip, or with extensive arthritis of hip. Usually one of three types of reconstruction operation is done: Whitman,⁷ Brackett,⁸ or Albee.⁹

5. *Amputation.*—There are cases which unquestionably would be better treated in this way. The deformity is so great, or the time to restore will extend into years, or malunion with osteomyelitis or associated complications is so impossible to otherwise treat. Such a case is Case XIV of Table I. This was a case following gunshot injury. The patient refused amputation.

Cases Actually Operated Upon with Results.—Sixteen of the thirty-two cases of malunion studied by me were operated upon. I did four of these operations and assisted at three of them, and various ones of my colleagues did nine. Operation was advised in many more, but for one reason or another was not performed. Since the operative treatment is so important, involves so many principles and is so difficult, complete report of the sixteen cases is given:

CASE I.—Male, aged seven weeks. Middle third left femur showed anterior lateral angulation with one and one-half inches shortening. Operation May 29, 1929: Closed reduction and application plaster spica. *Comment.*—Good result and should have been at this age.

CASE III.—Female, aged twelve years. Middle third, antero-lateral angulation with one and three-quarter inches shortening. Operation August 4, 1927: Six-inch lateral incision fragments separated, some of the callus removed, ends of bone brought into alignment with considerable force, Lane plate applied, then plaster spica. October 20, 1927, Lane plate removed, the screws being loose. *Comment.*—Slight lateral bowing and some limitation of motion at knee was the final result. Border-line operative case due to age—twelve years.

CASE IV.—Male, aged forty-five years. Impacted supracondylar with marked antero-medial angulation and two inches shortening; relaxation of ligaments of knee. *Symptoms.*—Feels as if knee was being forced outward, and pain in knee. Operation March 9, 1925: One-quarter inch wedge osteotomy through lateral incision, leg straightened and plaster-of-Paris bandage applied. *Comment.*—Patient had pleurisy following operation, but this cleared up; 140 degrees flexion at knee, the limb was symmetrical, brace fitted to patient for relaxation about knee. Good result considering associated injury to knee ligaments.

CASE V.—Male, aged nineteen years. Middle third, marked anterior bowing, large amount callus, two inches shortening. Operation August 22, 1928: Femur forcibly broken under ether anæsthesia and plaster-of-Paris applied after thigh was straightened. *Comment.*—Good results with flexion at knee limited to right angle. A simple case.

CASE VI.—Male, aged twenty-three years. Upper and middle third, marked lateral bowing, large amount callus, shortening two inches. Operation April 17, 1928: Six-inch lateral incision. Bone ends appeared to be at right angles. Large amount dense callus, line of fracture could not be identified. One and one-half inch wedge removed, bone not completely divided, lower portion abducted with difficulty till wedge was closed. Plaster-of-Paris spica. *Comment.*—Eleven days post-operative a blood-clot

RUSSEL H. PATTERSON

removed from wound, wound then healed. Discharged two and one-half months after operation with steel and leather spica brace. Exact final result not known.

CASE VII.—Female, aged twenty-nine years. Lower third right femur marked lateral bowing, three and one-quarter inches shortening, cavus of foot, marked limitation external rotation of foot. Operation October 4, 1923: Lateral incision, wedge removed at site of fracture, lower fragment abducted, fragments plated in this position, plaster-of-Paris spica. *Comment*.—Discharged with the general remark "improved." Knee with only slight motion.

CASE VIII.—Female, aged twenty-eight years, very obese. Middle third double fracture, marked antero-lateral bowing, equinus of foot, two inches shortening, had marked limp and walked with cane or crutch. Operation April 29, 1929: Spinal anaesthesia. Lateral incision, femur put in line by lifting and abducting leg, plaster-of-Paris bandage. June 3, 1929, tenotomy of achilles tendon. *Result*.—Stable extremity with marked stiffness in knee.

CASE IX.—Male, aged forty-seven years. Upper and middle thirds, transverse, three-inch overriding, two-inch atrophy thigh. Operation June 23, 1927: Lateral incision, fragments separated, ends freshened, Steinmann pin applied for traction. *Result*.—Solid bony union October 4, 1927, but marked stiffness in knee. Re-admission January 4, 1929, and a Bennett operation done on knee. February 1, 1929, knee stretched and skin broken over it. April, 1929, skin graft over knee. Final result May, 1929, solid union with marked stiffness in knee.

CASE X.—Male, aged twenty years. Middle one-third, backward bowing, overriding, excessive callus, marked limp. Operation December 8, 1924: Postero-lateral eight-inch incision, marked amount callus, fragments separated and it was found to be impossible to reduce the deformity on account of contraction and formation of bone, consequently a deep excavation cut in end of upper fragment and lower end shaped into this excavation and held by a bone screw, plaster spica. *Result*.—Died four days later, gas bacillus infection.

CASE XII.—Male, aged twenty-two years. Junction middle and lower one-third with three inches overriding, marked amount callus present. Marked limp, considerable pain in leg. Operation March 25, 1927: Gas-ether anaesthetic; lateral incision; fragments separated by chisel; ends freshened with saw; much excess callus excised—the callus extended out into the soft tissues like the fins of a fish—fracture reduced and ends apposed by traction through tongs and prying with Murphy hip chisel; wound closed; patient to ward and suspended in Balkan frame with Thomas splint and tong traction. *Result and comment*.—Even after tongs were applied on the operating table, much pulling and manhandling were also done and the fragments reduced at the time. The tissues were traumatized, large hæmatoma formed post-operative, absorption took place, then slipping of the fragments, then slow union extending over one year, and finally the patient left the hospital with the femoral fragments in the same malposition as on entrance.

CASE XV.—Male, aged fifty-two years. Intertrochanteric, large amount callus, coxa vara, adduction deformity, hip could not be abducted on account of impingement of callus and great trochanter on side of pelvis, knee almost stiff, with advanced arthritis, pain in hip. Operation March 9, 1929: gas-ether, osteotomy of femur, at level of lesser trochanter, extremity abducted to forty-five degrees, plaster spica. *Result*.—Motion (abduction) at hip increased, arthritis of knee greatly excited by operation and immobilization. Patient discharged with crutches and requesting amputation on account of pain and stiffness in knee.

CASE XVI.—Male, aged twenty-three years. Lower and middle one-thirds, overlapping three and one-half inches, much excess callus. Operation May, 1927: Gas-oxygen-ether anaesthesia, anterior incision bone fragments separated with chisel and hammer, excess callus removed, bone ends freshened, bone ends approximated with

MALUNION OF FRACTURES OF FEMUR

great difficulty, Lane plate, plaster spica. *Result*.—Patient died some eight hours post-operative shock. *Comment*.—Too much was attempted in this case. The amount of callus removed was considerable, the stretching of three and one-half inches on the table was very shocking, and the time of the operation was too long—one and one-half hours. Spinal anaesthesia might have been used, plating should have been omitted, and reduction should have been slow skeletal traction.

CASE XXX.—Female, aged twenty-two years. Middle one-third, bowing and over-riding three inches, heavy bone callus. Operation March 24, 1922; gas-ether, long antero-lateral incision, bone divided with chisel, excess callus excised, wound flushed with hot saline and closed. Tongs inserted in lower end of femur. Patient put in Balkan frame and Thomas splint. Traction by tongs, starting off with fourteen pounds and gradually increasing to sixty-five pounds, by the end of the seven days. This was maintained until the eleventh day when the sixty-five pounds were gradually reduced, over a period of thirty-five days, to ten pounds. On the day of maximum traction the pulse rose from ninety to one hundred and twenty where it remained until the thirty-fourth day, which was the day traction was finally reduced to ten pounds. The fragments were never brought end to end—a gain of two and three-quarter inches being at one time obtained, which was one-quarter inch from complete reduction. Tongs removed on the forty-fifth day, skin traction to eighty-third day, then Thomas ambulatory splint. Physical therapy begun. *Result*.—Patient seen one year and nine months later with “moderate overriding of fragments, bony union, outward bowing. Patient was pregnant, otherwise some operation would have been performed for malunion.”

CASE XXXI.—Male, aged nineteen years. Middle third left femur with three and one-quarter inches shortening and marked lateral angulation. Operation by Dr. H. M. B. March 7, 1930: Open osteotomy, removal of marked excess of callus, thigh straightened, position maintained by putting Steinmann pin through os calcis and incorporating this in plaster spica from chest to toes. X-rays six weeks after operation show one inch overlapping with callus (not homogeneous) being laid down. Still in plaster.

CASE XXXII.—Male, aged fifteen years. Neck of left femur. Marked coxa vara with osteitis fibrosa cystica of great trochanteric region. Operation June 1, 1929: Cuneiform osteotomy, plaster-of-Paris spica. September 6, 1929, right knee stretched and motion afterward possible to a right angle. October 10, 1929, wearing brace and crutches, very little motion in hip. Final result cannot be predicted on account of bone tumor.

Discussion of Operative Treatment.—These operative results are not encouraging. In children, as would be expected, the results are better. The children endure more, their tissues are softer, the reparative powers rapid and definite.

With the simple osteotomies results have been better—the operation shorter, manipulation less, less shock.

Three cases had shortening of three and one-half inches, two inches, and three inches respectively. After operation for malunion these cases ended with marked stiffness in the knees. This will happen frequently when stretching is employed to overcome shortening. Abbott has pointed this out, and advises knee motion in all cases during the post-operative treatment. Of course this is only possible by use of traction, and nearly always skeletal traction, after the osteotomy.

The worst type of malunion seems to be the one with marked deformity, marked increase in callus, and several inches of overlapping of the fragments. Results in the treatment of such cases have not been good—in fact, they

have usually been failures. Overcoming the shortening is where we have gotten into trouble. We can correct the bowing, we can remove the excess callus, we can separate the fragments, we can apply skeletal traction which will keep the joints in good condition, but if we prolong the operation by trying to immediately restore full length, then we traumatize the tissues, shock the patient, and infection, slipping of fragments, even death is liable to be the final result. Therefore, I would advise, at the time of the operation when the step comes to lengthen the extremity, that one of two procedures be adopted: (1) shorten the bone ends and appose them and be satisfied with loss in length, usually one to three inches, but with union and otherwise good function; or (2) do a "Z" or tongue osteotomy, get what increase in length slow skeletal traction will give, which may not be full length, and let union take place where it will.

Unless one has had experience with this type of case one cannot appreciate the disability to the patient and the hazards in the operative treatment and post-operative care. Most of the surgeons with whom I have discussed such cases have in the past been contented to "let the other man treat them." I believe this attitude will be changed if one of the procedures suggested above is adopted.

Operative treatment of these cases assumes that (1) there are no open wounds; (2) the skin is in good condition; (3) all infection has been cleared up at least, and better longer than, six months; (4) the patient can stand the operation; (5) the patient usually is not a child; (6) too much will not be attempted at time of operation; (7) the surgeon has a thorough knowledge of the treatment of a fresh fracture; (8) the after-treatment shall be carried out with, if anything, more skill and attention than if the case were a fresh fracture.

Summary.—Further points not emphasized under the discussion of operative treatment:

1. Eighty per cent. of the cases of malunion of the femur are preventable, being due to errors in treatment, usually changing treatment with slipping of fragments at the time.
2. Twenty per cent. of the cases of malunion of the femur are not preventable. Most of these cases are due to associated diseases or injuries.
3. Excessive callus at site of malunion is present in most cases. This may be an attempt of nature to repair and strengthen the deformity.
4. The treatment of cases complicated by osteomyelitis, extensive loss of bone, and associated soft part injury, is apt to extend over many years with a doubtful end-result. Therefore, amputation is to be considered in such cases.
5. The time element is a big factor in these cases. Treatment implies, first, refracture; second, prolonged treatment of the refracture (union nearly always slower in refracture cases); third, treatment of adjacent joints, muscles and tendons; fourth, often secondary operations, as tendon lengthening and stretching. All this may extend over a period of two years.

MALUNION OF FRACTURES OF FEMUR

6. Arthritis of one joint in the extremity (particularly the hip or knee) is apt, at times, to overshadow any good result one might get in the treatment of malunion.

7. Spinal anaesthesia should be considered in operative treatment of these cases.

8. Absorption of neck of femur with eventual solid union, impossible to prove not bony, does occur occasionally.

I wish to extend my appreciation to the following surgeons who were kind enough to loan me records and X-rays of several cases of theirs included in this paper: Royal Whitman, Lewis Clark Wagner, Richmond Stevens, and William L. Sneed.

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AN AMBULATORY TREATMENT OF MALLEOLAR FRACTURES

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THERE is a uniformity in the text-book teaching of the treatment of fractures of the external malleolus, with or without fracture of the internal malleolus, loosely (and frequently incorrectly) called Pott's fracture. It is to the effect that these fractures should be reduced, immobilized, either in plaster-of-Paris or other rigid splint, and relieved of weight-bearing for several weeks. Kellogg Speed,¹ in his text-book, is specific in advising relief of weight-bearing for eight weeks.

I have for several years been impressed with the protracted disability which frequently occurs as the result of such fractures, often with little or no displacement of the fragments. The patients at the end of six weeks or two months present a foot in which the circulation is sluggish; there is more or less infiltration, and there is a general restriction of motion in the joints of the ankle and tarsus. There is atrophy of musculature and the X-ray demonstrates atrophy of bone.

If one visualizes the sequence of pathologic changes which have occurred during that time period, the clinical picture will be made clear. One has only to observe the extensive ecchymosis that appears on the third or fourth day to realize that it signifies a considerable hæmorrhage into tissue spaces which surround a series of adjacent joints. The organization of this hæmorrhage results in the formation of adhesions, and accounts for the joint stiffness. The resumption of function under these conditions is accompanied by pain, swelling, and deformity. The foot gradually turns outward into an abducted attitude, and complete voluntary or passive adduction and reconstitution of the arch is no longer possible. This triad is generally recognized by the term "traumatic flat-foot."

The departure in treatment is based upon the observation of the disability incident to the ordinary so-called flat-foot. In the course of this very common condition, overworked adolescents and adults sometimes contract an exceedingly disabling condition called spastic or rigid flat-foot. It differs from the ordinary flat-foot in that the patient is no longer able to rise on the outer border of his foot, and thus reconstitute his arch. It is due to infiltration of the capsular structures of the joints of the inner side of the foot from chronic trauma. Long-standing cases develop adhesions which fix the joints. Clinically it is exactly comparable to the traumatic flat-foot outlined above. This paper has to do with the prevention of such a state of affairs by the early institution of movement and function. I have observed that these fractures unite when unrecognized, but with deformity.

TREATMENT OF MALLEOLAR FRACTURES



FIG. 1.—Attitude in which the foot should be held during the application of the adhesive plaster.



FIG. 2.—The adhesive-plaster dressing applied.

ARTHUR KRIDA

Union occurs because weight is borne through the tibia and not through the malleoli. The treatment involves the following elements:

1. If there is displacement requiring reduction, this is done, and a short period of rest is allowed.

2. In fractures with no displacement, two or three days' rest in a sheet-wadding-bandage compression dressing.

3. Following this, adhesive-plaster strapping is applied with the foot in dorsal flexion and adduction (Fig. 1), and with the toes in plantar flexion. The base of the dressing is two two-inch strips which begin on the outer side of the leg, passing downward across the os calcis, adducting that bone, and then upward on the inner side of the leg to the upper border of the calf. Over this are applied successive two-inch strips, encircling the limb from the base of the toes to the upper border of the calf (Fig. 2), but leaving a small segment of the heel uncovered. The patient is then instructed to begin systematic movements at the ankle-joint. In order to be assured that he uses his tibialis anticus muscle for dorsal flexion movements, he is instructed to keep his toes plantar flexed. The dressing sufficiently fixes the fragments so that no discomfort accompanies the exercise. Weight-bearing and walking in a shoe, the heel of which has been raised $\frac{1}{4}$ inch on the inner side, is encouraged after from three to six days after the injury.

4. The adhesive dressing is renewed every four or five days. The surgeon must be satisfied that exercises and movements are being properly carried out.

5. This régime of dressing is carried out for six weeks. Union is then sufficiently advanced so that no deformity will result. The raised heel is maintained, exercises and proper weight-bearing are encouraged until complete mobility is restored.

During the last year I have had occasion to treat seven patients in this manner—five private patients and two hospital cases. All were walking in from three to seven days; the convalescence was materially shortened, and union occurred without delay or deformity.

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FRACTURES OF THE SCAPULA

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FROM THE SURGICAL SERVICE OF THE BEEKMAN STREET HOSPITAL

THE scapula has always been considered a bone which is rarely fractured. Relatively little space has been given to this subject in text-books and little information is to be found in the literature. The fracture service of the Beekman Street Hospital, New York City, from which these cases are taken, have treated twenty-three cases of fracture of the scapula during the period 1926 to 1929 inclusive. One case was bilateral, thus making a total of twenty-four fractured scapulæ during the past four years. Three of these cases had no X-rays taken, because they either died or signed a release before sufficient time had elapsed. These three, not being proven cases, will not be considered. We will include, however, a case of fractured coracoid, taken care of privately by Dr. Thomas M. Lowry. This will make a total of twenty-one proven cases with twenty-two fractured scapulæ.

The ages of the patients in this series varied from eight to sixty-three years with an average of 36.7 years. There was only one under twenty-one years; there were nine between twenty-one and thirty-five; eight between thirty-six and fifty and three over fifty. This demonstrates that the age frequency is during the active-labor period. Twenty of the twenty-one patients were males. Most of the patients were of the foreign laboring type.

The occupations may be divided as follows:

I. *Hazardous labor.*—Thirteen cases, or 61.9 per cent.

	Cases
1. Laborer	7
2. Painter	2
3. Longshoreman	1
4. Ironworker	1
5. Carpenter	1
6. Fireman	1

II. *Moderately hazardous labor.*—Six cases, or 28.5 per cent.

	Cases
1. Helper	1
2. Butcher	1
3. Watchman	1
4. Schoolboy	1
5. Runner	1
6. Salesman	1

III. *Sedentary labor.*—One case, or 4.7 per cent.

	Cases
1. Housewife	1

ROBERT T. FINDLAY

IV. *Undetermined or unknown*.—One case, or 4.7 per cent.

The history or nature of the trauma may be grouped as follows:

I. *Falling injuries*.—Sixteen cases, or 76.2 per cent.

	Cases
1. Fell four stories from a scaffold after brick fell on head	1
2. Fell several stories from a derrick.....	1
3. Fell one story.....	1
4. Fell one story out of a window.....	1
5. Fell down a hatchway.....	1
6. Fell down eight stairs, striking arm and shoulder.....	1
7. Fell twenty feet from a scaffold.....	1
8. Fell twelve feet, landing on shoulder.....	1
9. Fell off ladder, landing on shoulder.....	1
10. Fell eight feet, striking shoulder.....	1
11. Fell backwards from a firetruck.....	1
12. Knocked down by a truck.....	1
13. Knocked down by an automobile.....	2
14. Knocked down by a taxi-cab.....	1
15. Knocked down during altercation.....	1

II. *Crushing injuries*.—Three cases, or 14.2 per cent.

	Cases
1. Crushed in freight elevator.....	1
2. Buried in excavation, crushed by rocks and cement.....	1
3. Caught in rising elevator.....	1

III. *Direct blow*.—Two cases, or 9.5 per cent.

	Cases
1. Struck on shoulder by iron weight.....	1
2. Struck on shoulder during altercation.....	1

It is obvious that fractured scapulæ usually occur following great violence; also, that the fractures are probably all due to direct force rather than transmitted force through the arm. The history of a fall on the out-stretched arm was not elicited in any of this series.

The type of individual, the nature of the trauma, the mechanism, and even the treatment of fractures of the scapula are analogous to that of fractures of the pelvis.⁶

The following two paragraphs will demonstrate the severity and multiplicity of the injuries received and their complications, also the relative unimportance of the fracture of the scapula *per se*.

Other fractures and dislocations.—Fractures of the skull, five; nasal bone, one; clavicle, two; ribs: unspecified, one; third rib, two; fourth rib, four; fifth rib, three; sixth rib, two; seventh rib, one; eighth rib, two; ninth rib, one; tenth rib, one; fifth metacarpal, one; transverse process, fourth lumbar vertebra, one; radius, two; ulna, two; dislocation of radio-ulna joint, one; fractures of the ilium, one; ischium, one; separation of the symphysis pubis, one; fractures of the tibia, one; and fibula, two cases.

Other injuries, diseases, and complications.—Only four cases had none. The others were: cerebral concussion in ten cases; laceration of the brain,

FRACTURES OF THE SCAPULA

one; scalp, seven; axilla with hæmorrhage, one; scapular region, one; thumb, one; anal region, one; perineal region, one. There were contusions: multiple, two; of the scalp, one; scapular region, two; shoulder, two; chest, four; back, two; forearm, one; pubic region, two; inguinal region, one; and leg, one. There were also abrasions: multiple, two; scalp, one; face, one; shoulder, one; chest, two; scapular region, one; pubic region, one; and leg, one. Other conditions were: extradural hæmorrhage, one; profound shock, two; ruptured pleura, one; ruptured bladder, one; hæmatoma of the right eye, one; pneumonia, two; conjunctivitis, one; abscess of scapular region, one. It was interesting to note that there were no severe injuries of the soft parts from the fragments of the fractured scapulæ. The one case of the ruptured pleura was due to a fractured rib, not scapula.

The following *symptoms and signs* were present which were attributed to the fractured scapula: local pain in eighteen cases; local tenderness in sixteen; temporary loss of function of the arm was noted in six; temporary partial loss of function of the arm was noted in three. In one case, specific mention was made of the fact that there was no difficulty or pain on motion of the arm, and three were noted to have pain on motion of the arm. No symptoms of any value could be elicited from two of the cases who were unconscious most of the time during their stay in the hospital. Probably due to the multiplicity of the injuries and to the serious condition of most of the patients and the fact that most of them were in shock on admission, the symptoms and signs are very briefly recorded. Scudder⁵ mentions the above findings, also crepitus and abnormal mobility in fractures of the body; flattening of the shoulder in fractures of the acromial process, especially if the fracture involves the acromio-clavicular joint; a similarity to dislocation of the head of the humerus and the prominence of the acromion and lengthening of the arm in fractures of the neck. The clinical features of fracture at the neck are referred to by Cotton and Brickley¹ as follows: Position of the shoulder: displacement inward with the shoulder obviously narrower than on the other side, obviously driven in and held in this abnormal position by muscle spasm. Fracture of the neck has been discussed in detail by Hitzrot and Bolling.³ They stress the point that the old descriptions of the clinical features of fractures in this region are obsolete due to inaccuracy. These original descriptions were made in the days before the X-ray. Some of the cases described as fractures of the scapula were fractures of the humerus. They further stated that fractures of the neck of the scapula may occur in which there is no distinguishable deformity and that there is no displacement that can be affected by raising the arm or by traction. Traction suspension apparatus was evidently not tried.

Hospital morbidity.—This refers to the number of days' stay in the hospital: the lowest, one; the highest, forty-two; the average, 14.4 days; and one was treated ambulatorily. The morbidity findings mean nothing as the length of stay in the hospital was almost invariably due to complicating injuries. There were only two cases that did not have complicating injuries.

One of these remained in the hospital for thirty-five days, because of an open operation for removal of a fractured coracoid process; the other was also a coracoid which was treated ambulatorily. Whether a fractured scapula should be treated as a bed case or ambulatorily will be discussed under "Treatment."

The locations of the fractures in this series were as follows: Body, fifteen, or 57.7 per cent.; glenoid, five, or 19.2 per cent.; coracoid process, two; acromion, two; neck, one; and spine, one. It will be noted that this is a well-distributed list, as all of the regions of the scapula are involved.

Displacement of the fragments was noted in eleven of the twenty-six fractures, or 42.3 per cent., the degree of separation varying nearly up to an inch.

There were no compound fractures in this series; four were multiple and two were comminuted.

Mortality.—There were three deaths, or 14.3 per cent., all from complicating injuries. These three fatal cases all had fractured skulls.

Treatment.—As has been mentioned above, the patients in this series were all bed cases with one exception, the time in bed varying from three to thirty-seven days with an average of about fifteen days. This length of time was due to complicating injuries. The treatment in this series, aside from rest in bed with the patient flat on his back, consisted of a Velpeau bandage in one case, Sayre adhesive dressing in two, immediate sling in one, and sling after ten days in several. In one case the arm was placed in suspension with traction and abduction. This case was so placed following operation for removal of a fractured coracoid process. Open operation was done in only one case. This was the case mentioned above—fracture of the coracoid process and body. Due to separation and rotation of the fractured coracoid process and persistent pain, the coracoid was removed through an anterior incision. The arm was placed in suspension-traction-abduction for eleven days, following which the arm was placed in a sling and physiotherapy given. Pain was relieved but the final functional result was poor. This case was discussed by Dr. Ralph Colp, of our staff, who was inclined to favor conservative treatment in fractured coracoids. Connors also described a fractured coracoid which had been wrongly diagnosed as a fracture of the greater tuberosity of the humerus and treated by immobilization. A good result was obtained in a few weeks by the use of motion and other physiotherapy.

There are several other points brought out in the literature on the treatment of fractures of the scapula which it may be well to discuss here.

Fracture of the body.—No mention is made whether these cases should be treated in bed or not. Scudder⁵ advises immobilization of the arm by a sling and bandaging the arm to the chest. Longabaugh⁴ described a fracture of the lower end of the body in which the rhomboideus major muscle was partly detached, so that on raising the arm the scapula winged outward

FRACTURES OF THE SCAPULA

instead of being anchored. It was necessary to remove this lower fragment by open operation in order to effect a cure.

Fracture of the neck.—Scudder⁵ advocates traction-abduction of the arm with the patient in bed. Cotton and Brickley¹ advocate the following method of reduction and treatment: Reduction by leverage of the humerus across the fist in the axilla as a fulcrum; pad in the axilla; arm held at side. Pillow in back between scapulæ and sandbag anteriorly. Fracture board under mattress. Three weeks in bed with hypnotics. Massage after two weeks; motion after three weeks. Hitzrot and Bolling,³ in reporting eight cases, stated that manipulation or traction had no effect on the lesion and all were abandoned for a Velpeau bandage; also, that massage and baking and careful attention to the after-treatment will give practically perfect functional results, that the resulting function is so satisfactory that ill-advised attempts at correction are to be condemned. Should a type of fracture occur in which the displacement actually promised a bad functional result, the fracture line could be best approached from behind and the glenoid fragment pried into position in this way with correction of the coincident injuries by appropriate methods, (repair of ligaments, etc.).

Fracture of the acromial process.—Scudder⁵ states that there is difficulty in maintaining reduction by any apparatus. He flexes the forearm, lifts the arm upward, and applies counter pressure on the inner fragment, followed by a heavy bandage, and states that union will occur in three to four weeks. Darrach² describes a case of an old fracture with non-union; the fragments at operation were found to be joined by a firm band of connective tissue. The band was severed and the bone edges freshened and sutured with silk. There was firm union after four weeks of immobilization. He also tells of a similar case in which Dr. Charles H. Peck placed a Lane plate with an excellent result.

It is difficult to come to any very definite conclusions in regard to the treatment of these fractures and it would be absurd to advocate methods of treatment which we have not tried. In fractures of the body, however, we are able to make some definite recommendations as we have treated a sufficient number of cases and obtained good results. Thus, in the absence of complicating injuries or whenever practicable, the following principles of treatment could be followed in fractures of the body:

Incomplete.—Ambulatory, sling, and physiotherapy consisting of heat, massage, active and passive motion every second day beginning after three days and lasting from two to three weeks, after which time sling can be discontinued.

Complete.—Whether fragments are displaced or not, flat on back in bed with immobilization of shoulder and arm by a Velpeau bandage. After ten days patient to be allowed out of bed, arm placed in sling, discharged from hospital and given physiotherapy as above for three or four weeks, making a total of about five weeks' treatment.

In fractures of the glenoid, the following suggestions are offered. Bearing in mind that these fractures are into the shoulder-joint, early motion is important unless there is so much separation of fragments as to move the fragments when the arm and shoulder are moved. Thus, if there is great separation, these should be treated by immobilization for three weeks in a Velpeau bandage with the patient in bed followed by sling and physiotherapy, consisting of heat, massage, active and passive motion. If there is not great separation, put the patient to bed with no further immobilization, for three days, and then allow patient to get up, with the arm in a sling, and to be dis-



FIG. 1.—D. P., male, aged thirty-six. This patient fell twenty feet from a scaffold, landing on the shoulder. After admission the patient was unable to move the arm, and there were pain and tenderness in the scapular region. Besides having a fractured scapula, he had contusions and abrasions of the scapular region and cerebral concussion. The above tracing of the X-ray shows a comminuted fracture of the body of the scapula extending into the lower tip of the glenoid, with a separation of over half an inch. This man was kept in the hospital for ten days, during which time the shoulder was immobilized in a Velpeau bandage. At the end of eight days the arm was put in a sling and active and passive motion started. Result good.



FIG. 2.—D. Z., male, aged fifty-five. Fell from a ladder, landing on the shoulder. On admission there were pain and tenderness in the scapular region and pain on motion of the arm. Besides a fracture of the scapula, there were the following injuries: Fracture of the skull, laceration of the scalp, and laceration of the brain. The above X-ray tracing shows a complete fracture, transversely through the body of the scapula, extending into the spine, neck and glenoid, with a separation of about one-half inch. No special treatment was instituted for the fractured scapula. The patient died after three days of the head injury.

charged from the hospital and to receive daily physiotherapy, consisting of heat, massage, active and passive motion.

In fractures of the coracoid process, we have already inferred that conservative treatment is probably advisable.

We can offer no special suggestions in fractures of the neck. We do not know whether displaced fragments could be reduced by manipulation under a general anæsthetic or not. It might be worthwhile trying this for a marked displacement and placing the arm in suspension-traction-abduction and the patient in bed.

We have never tried to reduce a displaced fracture of the acromial

FRACTURES OF THE SCAPULA

process. It might be advisable to try this by manipulation under general anaesthesia, followed by immobilization of the shoulder and physiotherapy.

Results.—The immediate results were recorded as follows: good, in seventeen cases; fair, in one; and three died. Satisfactory follow-ups were obtained in only eight cases, or 38 per cent. Although this percentage is quite low, it is considered fairly good as the majority of these patients were of the foreign laboring type, most of whom have no permanent residence.

Follow-up.—(1) Fractured glenoid, crushed inward, in a man who is now sixty-six years of age, seen after three years with perfect anatomical and functional result and no symptoms.

(2) A fractured neck and glenoid with displacement of the fragment laterally into the shoulder-joint in a man who is now forty-three, seen after two and one-half years. He had been doing his regular work as a subway motorman for over two years. Abduction of the arm was found to be 100° and forward elevation of the arm 145° . This man's legal case had not been entirely settled. Examination gave the impression that the shoulder was muscle-bound and that the settling of the case would tend to improve the function of the shoulder.

(3), (4), and (5) Fractures of the body without separation of the fragments. The first, a man of fifty-two, seen after four years, had an excellent anatomical and functional result; the second, a man of twenty-seven seen after four months, also had an excellent anatomical and functional result; the third, a man of thirty-two, had an excellent anatomical and a functional result of 85 per cent.

(6) Fracture of the acromion and body (see Fig. 3) with one-half inch separation of fragments, a man of twenty-five, who, at the end of three months, had some irregularity of the acromion with moderate limitation of motion of the shoulder.

(7) and (8) Fractures of the coracoid. The first, a man of forty-one, with a separation and rotation of the coracoid, for which operative removal of the coracoid was done by Doctor Colp with a rather poor functional result after about a year; the second, a man of thirty, Doctor Lowry's private case, who had a fractured coracoid with slight displacement, obtained an excellent anatomical and functional result when seen after two and one-half months. Sayre adhesive dressing for one week, followed by sling and motion and other physiotherapy, was used in this case.

The accompanying X-ray tracings (Figs. 1, 2, and 3) show three rather severe cases of fractured scapulae with separation of the fragments.

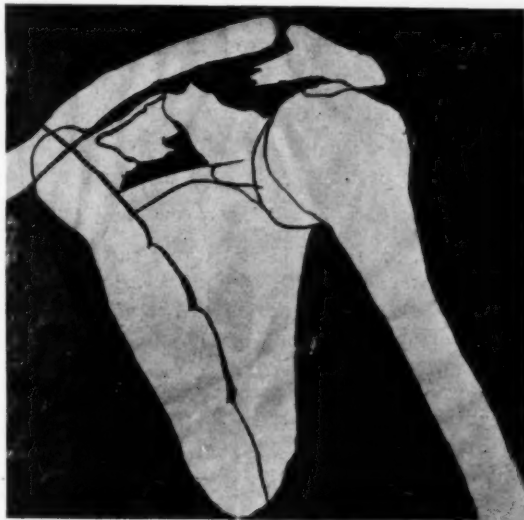


FIG. 3.—M. O., male, aged twenty-five. Fell four stories from a scaffold after a brick had fallen on his head. On admission the patient was unable to raise the arm and had pain and tenderness in the scapular region. Besides the fractured scapula, there were the following injuries: Fracture of the skull, cerebral concussion, laceration of the scalp, abrasions of the face and contusion of the shoulder. The above X-ray tracing demonstrates a complete fracture of the acromion with separation of about half an inch, also a fracture of the body just above the spine. The patient was kept in the hospital in bed for twenty-two days because of his other injuries. He received physiotherapy, i.e., massage, active and passive motion of the arm and shoulder, but no further treatment for the fractured scapula. The hospital result was considered only fair. The final result was also fair as a three months' follow-up showed some irregularity of the acromion and some limitation of motion of the shoulder.

ROBERT T. FINDLAY

CONCLUSIONS

1. Fractures of the scapula usually follow great violence.
2. They are usually associated with other injuries.
3. The associated injuries often interfere with any definite plan of treatment for the fractured scapula.
4. Most cases are treated by closed methods.
5. The staff of the Beekman Street Hospital have treated only one case in the past four years by open operation, and that unsuccessfully.
6. It may seem reactionary to outline any definite methods of treatment, as we have already stated in conclusion No. 3 that the associated injuries often interfere with any definite plan of treatment for the scapula; however, it will be well to have some more or less definite principles to bear in mind in order to avoid a too summary treatment of the fractured scapula just because the patient happens to have other more serious injuries.

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CALCIFICATION IN CALLUS FORMATION AND FRACTURE REPAIR

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OSSIFICATION is a local transformation of fibrous tissue into solid bone, the constituents of which are derived from the blood. The mechanism of this local chemical change is not understood and so the problems of normal and pathological calcification have been approached essentially from the systemic standpoint. Obviously, such a procedure limits our understanding of chemical bone pathology. We have seen cases of obvious rickets as well as delayed bone union resist the systemic treatment and so we have initiated some studies on the local chemical processes involved in calcification. A study of the mechanism of the repair of fracture offers another approach to a possible solution of a variety of orthopædic problems which are definitely non-systemic in etiology. Though the formation of callus is not a phenomenon *sui generis* and is a resultant of several factors favoring osteogenesis, it nevertheless offers an experimental method for the evaluation of the nature of the local pathology involved in delayed bone union. This paper is concerned with the relation of callus formation to calcification.

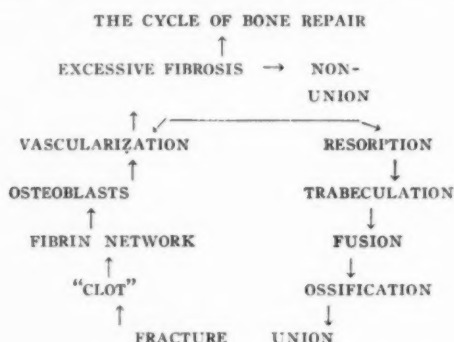
The Mechanism of Bone Repair.—The site of fracture following trauma consists of a blood-clot infiltrating the surrounding tissues. The retraction of the fibrin results in a network around the fragments which rapidly becomes invaded by fibroblasts in several hours. This is followed by a metamorphosis of the fibroblasts into osteoblasts with the formation of a soft or fibrous callus. This connective tissue organization of the clot is accompanied by the formation of penetrating capillary vessels.

The vascularization is a vasomotor reaction following fracture, thus bringing about a softening and resorption of the bone ends, a process preparatory for normal bone union. Any interference with these stages preliminary to osteogenesis alters the ultimate formation of solid callus. Trabeculae of young bone tissue begin to appear between the periosteum and diaphysis adjacent to the bone in the organized clot, thereby gradually producing bone union.

The bone in its early stages is coarse, soft, and of slighter density than in its adult stages. If too great an amount of fibrous tissue is laid down in the course of callus formation, the tendency is toward non-union and very often in the soft callus or cartilage stage one will be surprised to find a large, diffuse, palpable callus without any apparent calcification as revealed by X-ray. The fracture will feel fairly firm and solid yet one is never justified in concluding that bone union has taken place.

In certain cases re-fracture takes place, either accidentally or during manipulations to improve position, and it appears that new callus is formed with great rapidity. This is due to the fact that the local changes necessary for this function have already been instituted and it is only necessary to initiate the finer changes.

In the light of the local pathology following trauma, a fractured bone is repaired because of hæmorrhage of the soft parts of the actual break in bone and of the paralytic vasodilation. The hæmorrhage results in clot formation. Embryonic connective tissue appears. The vasodilation produces œdema in the soft tissues and resorption of the fractured ends of bone. The calcium salts thus made available locally are absorbed by the fibrin network which with gradually increasing density gives rise to bone.



The Nature of Delayed Union.—Delayed and ununited fractures have a common cause, the difference being a matter of degree. The time required for union varies in the different bones but so long as union is progressing the fracture is regarded as delayed. When organization of the exudate about the fragments is reached so that further osteogenesis is impossible non-union is inevitable. The causes are local rather than constitutional, proved by the fact that local treatment is effective in inducing union in most cases.

Systemic Causes of Non-union	<ul style="list-style-type: none"> (1) Focal infection. (2) Thyroid disease. (3) Multiple fractures. (4) Debility.
Local Causes of Non-union	<ul style="list-style-type: none"> (1) Inadequate reduction. (2) Inadequate fixation. (3) Circulatory interference. (4) Interposition of muscle. (5) Repeated reduction.

In non-union, condensation of callus takes place upon the ends of the fragments with failure to bridge the defect with solid bone. The callus upon the proximal fragment is usually in excess of that upon the distal end, resulting in the formation of nodular prominence on the proximal fragment with a cavity into which the distal fragment articulates. On the other hand,

CALCIFICATION IN FRACTURE REPAIR

there may be no reaction of the bone to form callus with resulting atrophy of the fragments.

Delayed union of bones may be due to either mechanical or to chemical causes. Obviously a variety of conditions may prevent union. The fragments may not be in apposition. There may be inadequate fixation or reduction. Frequently the process is actually interfered with by repeated examinations and finally there may be actual injury to the local blood supply preventing the continuous availability of blood constituents necessary for repair.

Chemical causes locally may be productive of delayed union. Tissue injury at the site of fracture results in hæmorrhage. Decomposition of the hæmatoma yields amino-acid, which decalcifies the bone ends (Henderson). The blood phosphates are made available for bone formation by a hydrolyzing enzyme present in the ossifying cartilage (Robinson). A marked increase in the local hydrogen-ion concentration tends to decrease the effective enzyme activity.

Constitutional treatment for delayed and ununited fractures is of no avail once non-union is imminent. The problem is local, confined to the site of fracture. Attempts at increasing the calcium and phosphorus concentrations of the blood by antirachitic measures have failed to show any effect upon the local condition. The stimulation of callus formation has been attempted by Bier's hyperæmia maceration of the fragments under anæsthesia, injection of blood, iodine, osmic acid, calcium salts, phosphates, into the point of fracture. And finally, functional use of the fractured extremity, surgical fixation or bone grafts.

Experimental Procedure.—Three groups of rabbits in two separate sets of experiments were studied for the degree and rate of callus formation and calcification. Each rabbit was anæsthetized with ether, blood taken from the heart for chemical analyses and the tibia fractured in mid-shaft. The fracture was immediately put into a plaster-of-Paris case and as soon as this had hardened sufficiently a fenestration was made to allow the introduction of the solution used. These preparations were introduced aseptically through the fenestration directly into the site of fracture. Some of the animals were maintained on the regular diet of hay, oats and leafy greens and the others were put on a special diet. The first group of animals was injected with five cubic centimetres of a 1 per cent. solution of trypsin buffered at 37° C. in the following solution pH 7.4 consisting of 100 cubic centimetres each of:

NaHCO ₃	0.03 per cent.
NaCl	N/10.
MgSO	0.0016 per cent.
K ₂ HPO ₄	0.009 per cent.

The injections were given at twenty-four- to thirty-six-hour intervals; a long needle was used, being introduced about an inch above the fractured site in healthy tissue so as to preclude as far as possible the danger of infection. The second group of rabbits was treated in exactly the same method with the exception that a tissue extract (fibrinogen) was substituted for the trypsin, one cubic centimetre of the sterile solution being injected immediately upon fracture into the hæmatoma. The third group constituted the control.

BERG AND KUGELMASS

These animals were subjected to the same treatment except that no solutions were injected into the site of fracture. The animals were watched carefully for evidence of vascular disturbance which might arise from too snugly fitting plaster bandaging, and in case this occurred new bandages were immediately applied. All animals were X-rayed each week to furnish a basis of comparison in the amount of callus thrown down. Specimens were removed from the animals killed at two- and four-week intervals. These were decalcified *in toto* in a 5 per cent. nitric acid. Longitudinal sections were then made with a very sharp blade for photographs and measurements of the callus. Microscopic sections were finally made from the centre of the callus.

Discussion.—Experimentally induced fractures in animals revealed that, all other conditions remaining constant, the amount of available fibrous

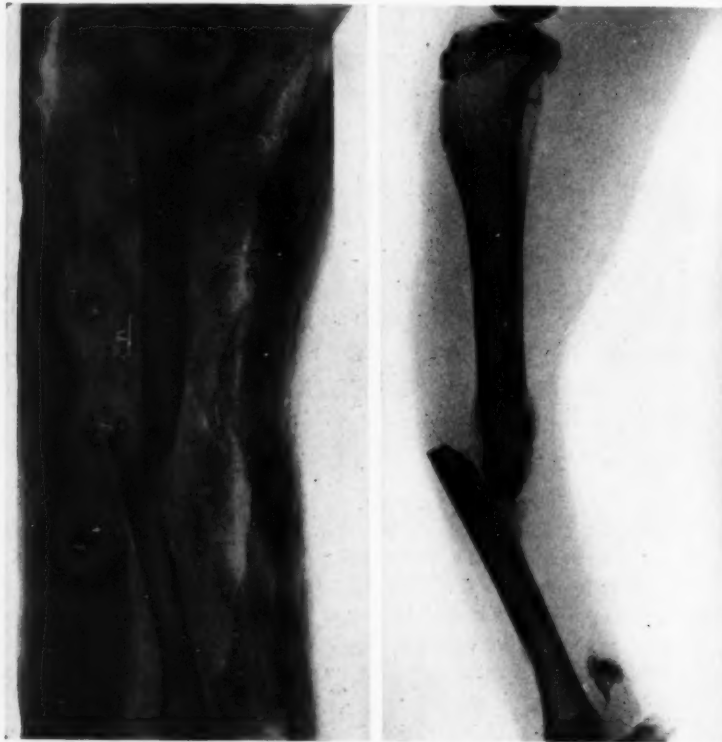


FIG. 1.—"Trypsin" series. First and fourth week. (Slight bony union.)

tissue is directly proportional to the degree and rate of calcification. The dissolution of the fibrous tissue normally formed following fracture, by means of an alkaline trypsin solution, diminished both the quantity and rate of bone formation during the course of bone repair. On the other hand, the local injection, at the site of the fracture, of tissue fibrinogen which in itself contributed to the available fibrous tissue content and simultaneously stimulated the fibrous tissue production, increased both the amount and rate of bone formation. Attempts to alter the local fibrous tissue production by means of high protein diet were ineffective in comparison with results obtained by controls. Histological studies revealed similar results. This

CALCIFICATION IN FRACTURE REPAIR

study indicates that the mechanism of bone repair may be altered by the local introduction of substances involved in the process and vary strikingly in comparison with the indefinite results obtained by attempted systemic therapy.

Bone repair involves: (1) the proximation of the fractured ends; (2) their initial union with the network of fibrous tissue; (3) the transformation of this fibrous network by solid calcium salts. Obviously, any interposition of muscle or fascia between the fractured ends of bone will prevent the formation of the fibrous network. Local alterations in tissue may diminish the available production of fibrous tissue and hence result in a fibrous network inadequate to span the fractured ends. Finally, any injury

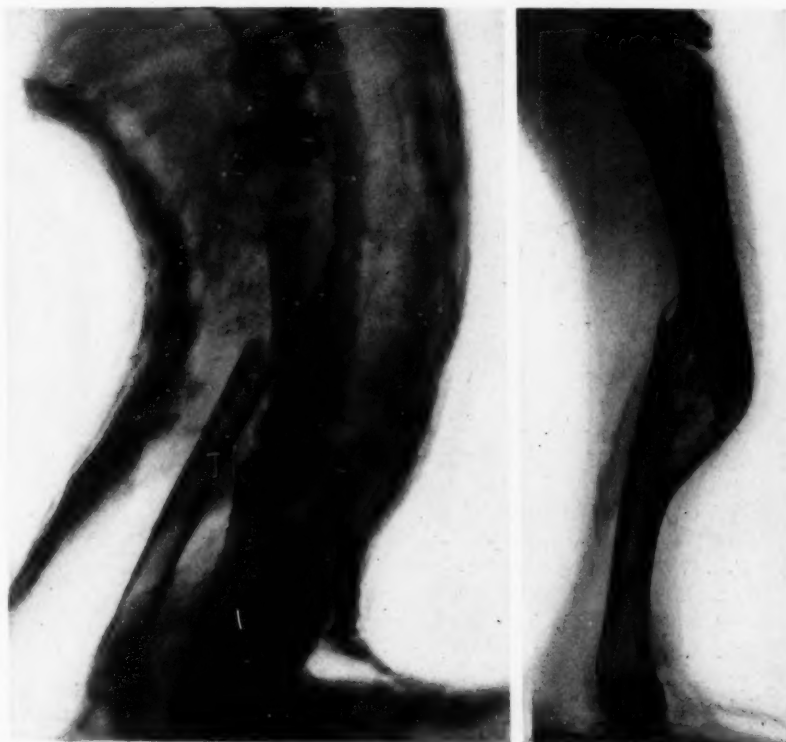


FIG. 2.—“Fibrinogen” series. First and fourth week. (Solid bony union.)

to the circulation will decrease the available supply of blood constituents necessary for the formation of bone tissue.

The trauma which caused the fracture simultaneously produces hæmorrhage. The blood enmeshed in the fractured ends forms the clot of fibrin. Injury to the periosteum favors additional fibrous tissue formation in this network. There is a definite relation between the mechanism of blood coagulation and this subsequent stage of calcification. Freshly formed fibrin has a greater adsorption capacity for calcium salts; hence, the more fibrin or fibrous tissue available, the more rapid will be the bond of union between the two fractured ends. The initial supply of calcium salts available for

adsorption by fibrinogen is obtained by local amino-acid formation which dissolves at least 20 per cent. of the exposed bone ends. The subsequent and continuous supply of calcium salts is obtained from the blood. The spontaneous healing of fractures thus depends upon the local hæmorrhage induced by tissue trauma. There is no providential protection of the unity of the skeletal structure—unless the conditions are favorable, healing will not take place.

Chemical determination of the blood constituents involved in the calcification process revealed certain alterations in the content according to the



FIG. 3.—“Control” series. First and fourth week. (Good bony union.)

local conditions of the fracture and its treatment. The control series of animals showed that the normal course of fracture repair involves an increase in the calcium level of the blood with a decrease in the phosphorus content. The bone repair therefore appears to be a process of phosphorization rather than of calcification. The injection of tissue fibrinogen at the site of the fracture tended to increase the blood calcium with the simultaneous decrease in the controls. This difference in blood effect produced by the introduction of tissue fibrinogen is explicable on the basis of the relative rates of bone repair. It has been repeatedly shown that the protein content of the blood is related to the total calcium injection. Half of the protein concentration is bonded to blood proteins as calcium proteinate. Fluctuations of the blood

CALCIFICATION IN FRACTURE REPAIR

calcium with variations in total protein of the blood have been observed in nephritis and other diseases where the protein metabolism is altered. A high-protein diet favors an elevated blood-calcium level, particularly if the blood-calcium level is below normal. The high-protein diet maintained a higher calcium level than the controls but all were well within the normal range. Protein injected in the form of tissue fibrinogen injected locally showed a similar trend. Diminution of other blood constituents involved directly or indirectly in the process of blood calcification revealed no change with alterations in the treatment of experimentally induced fractures.

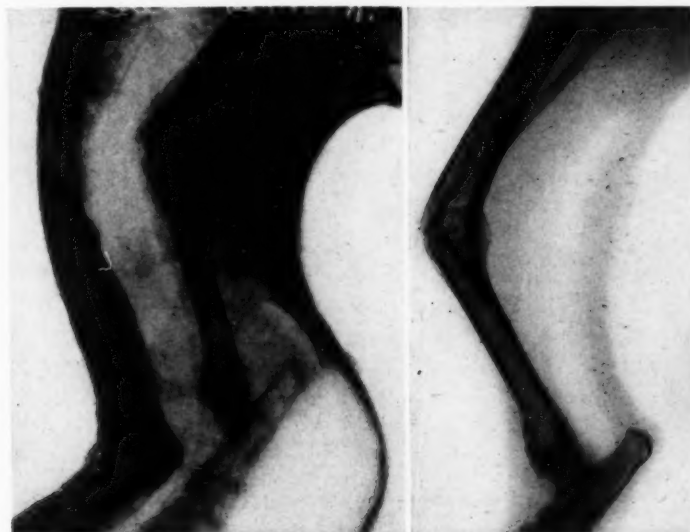


FIG. 4.—"Dietary" series. First and fourth week. (Beginning bony union.)

	Mg. Ca. 100 cc.	Mg. Phos. 100 cc.	Mg. Fibrin 1 cc. pl.	Alb. per cent.	Glob. per cent.
INITIAL BLOOD DETERMINATION					
FIRST SERIES					
(1) Trypsin group	13.0	5.6	.12	5.1	1.4
(2) Control group	13.0	7.8	.14	5.3	1.5
(3) Manipulated fractures	13.0	7.9	.14	4.1	3.6
FINAL BLOOD DETERMINATION					
SECOND SERIES					
(1) Trypsin group	13.1	5.5	.61	4.8	2.6
(2) Fibrinogen group	qns.	qns.	.33	3.9	.67
(3) Control group	9.7	5.4	.39	3.7	2.7
(4) Diet group	14.3	6.7	.25	4.2	3.3
Blood of May 2					
SECOND SERIES					
(1) Trypsin group	13.	4.1	.28	4.0	3.2
(2) Fibrinogen group	14.	3.5	.83	4.0	3.4
(3) Control group	12.	3.5	.24	3.7	3.7

BERG AND KUGELMASS

Blood of May 7

THIRD SERIES

(1) Trypsin group	14.	3.6	.23	4.1	2.4
(2) Fibrinogen group	14.	3.8	.56	4.0	2.5

THIRD EXPERIMENTAL SERIES

BLOOD DETERMINATIONS FROM TIME OF FRACTURE TO TIME OF UNION

Blood of April 11

	Rabbit	Ca.	Phos.	Fib.	Alb.	Glob.
Trypsin group	1	14.5	6.61	.379	4.43	3.34
	2	13.2	5.99	.465	4.34	1.78
	5	14.8	5.37	.253	4.21	1.41
	6	13.8	7.40	.512	4.70	1.13
Fibrinogen group	7	14.4	7.00	.288	4.34	.57
	8	9.8	9.52	.338	4.29	1.66
	9	8.0	qns.	.669	4.83	2.59
	10	14.2	4.31	.425	4.54	2.21

Blood of May 2

Trypsin group	1	12.8	3.37	.219	4.50	2.87
	2	13.8	3.73	.208	4.47	1.79
	5	15.2	4.16	.277	3.47	2.87
	6	14.8	3.51	.221	4.21	2.31
Fibrinogen group	7	14.4	3.75	.487	4.70	2.12
	9	14.4	3.93	.618	3.40	3.09
	10	14.4	3.77	.575	4.05	2.41

Blood of May 13

Trypsin group	1	14.1	4.00	.305	3.92	3.07
	2	13.8	4.50	.221	4.17	2.72
	5	16.8	3.80	.229	qns.	..
Fibrinogen group	9	16.0	3.75	.465	4.15	2.46
	10	14.6	3.84	.508	3.90	2.34

CONCLUSIONS

1. The relation between callus formation and the amount and rate of calcification was studied in rabbits with experimentally induced fractures.
2. The greater the local fibrous-tissue formation, the greater the amount and degree of calcification, all other conditions remaining the same.
3. The blood calcium tends to be higher and the phosphate lower in the course of normal bone repair and the more rapid the rate of calcification the more marked is this alteration in the calcium and phosphate content of the blood.
4. Injection at the site of fracture of alkaline trypsin solution to produce fibrous dissolution markedly retarded bony union in comparison with the control series.
5. Injection at the site of fracture of tissue fibrinogen solution to stimulate increased callus formation markedly accelerated bony union in comparison with the control series.

SURGICAL MANAGEMENT OF CRANIAL INJURIES*

By JOHN STEWART RODMAN, M.D.

OF PHILADELPHIA, PA.

I HAVE chosen the "Surgical Management of Cranial Injuries" as the subject of this address, first, because there are no general surgeons exempt from the necessity of handling such cases; second, because in spite of the voluminous literature on this subject, there is still no absolute uniformity of opinion as a whole, and third, because it is a subject in which I have been interested for some years. It is not a subject to which I can bring revolutionizing ideas, however, but rather one which I shall consider from the general surgeon's point of view. The neuro-surgeons have added considerably to our knowledge of the many problems presented by head injuries in general. I have drawn freely from the experience and comments of this especially interested group.

Head injuries are at the same time the oldest and newest subject in surgery. Even prehistoric man developed a certain skill in trephining. Just how early the practice of cutting holes in skulls to relieve fractures and to let out evil spirits was followed has not been determined, but Dr. George Duncan, anthropologist, has stated in recent studies of prehistoric disease, medicine and surgery, that such was undoubtedly done "in a great many unrelated places on the earth's surface."

One skull found in Peru showed that some early physician worked feverishly in an attempt to relieve a basal fracture of the skull before death overtook the patient. Indentations, epilepsy, melancholia, headache, and even magic, seemed to have been indications for trephining. Certain it is that some of these prehistoric people lived among their fellows with soft spots on their heads—the bone was cut or scraped out with flint, and later, with metal knives: skulls having been found with as many as five trephine openings. Such skulls have been found, not only in Peru, but in France, Denmark and Algiers.

The earliest records come from Egypt, which show that such trephinings were done there. We also find in the poems of Homer, which may be accepted as dating from about 1000 B.C., allusions to head injuries, as well as to many other parts of the body. Hippocrates, writing on this subject, begins his comments on such injuries by one of the very few inaccurate observations he was guilty of in describing the sutures of the cranium—namely, that the number and position of the sutures varies with the form of the head; that the coronal suture is wanting when there is no anterior protuberance of the skull and that the lambdoid suture is lacking if there is no posterior protuberance. He is the first, however, of whom I have

* Annual Oration before the Philadelphia Academy of Surgery for 1930.

found record who has devised a classification of head injuries—a form of amusement to surgeons ever since then.

Hippocrates thus divided fractures of the skull into four classes, (a) simple fissure, (b) contusions without fracture or depression, (c) indentations of the outer table and (d) fractures by *contra coup*.

Celsus speaks at some length on the subject of head injuries, quoting from Hippocrates. He seems to have more clearly understood indications for conservative or radical treatment as the particular case might warrant. To distinguish a fissure from a suture, he advises the pouring of ink on the part and then scraping the bone; if there is a fissure, the ink will mark it. All depressed bone is to be removed, but no more is to be taken away than is absolutely necessary. He would delay operating otherwise unless dangerous symptoms arise—for at least five days. Galen believed that depressed bone should be removed, but that fissures do not require operation. Paulus seems to have followed Galen, so that Greek and Roman methods of that early day did not differ, in some respects at least, from the conservative attitude toward operation of the majority of this time.

Like surgery in general, no real advance in the management of head injuries was made during the early centuries following the Christian era. Many references may be found referring to this subject, however, amply proving the interest which brain injury has always aroused, as well as the frequency of such injuries long before the motor car of today was dreamed of.

Head injuries have always been a large part of the army surgeon's concern. Thus, in the thirteenth century, Roland, of Parma, wrote a book on the subject, dealing largely with fractures of the skull and wounds of the head, for this period followed closely on the age of chivalry. Then knights in full armor carried on war and their weapons were the lance, mace and battle axe. These warriors were always mounted, and the head was the part aimed at. Roland's knowledge of the important clinical signs of various types of head injury was considerable, and his observations at times would do justice to a well-informed surgeon of today. Thus, he states that fractures of the skull may occur with or without a wound of the scalp, but that the important matter is the injury which has involved the brain or its immediate coverings. This thought has been repeated many times since the thirteenth century, but how many today still think of a given case as having died of a fracture of the skull! Roland went so far as to attempt to differentiate between injuries to the *dura* and to the *pia*. In injury to the *dura*, he states that there is pain in the head, redness of the face, inflammation of the eye, wanderings of the mind and blackness of the tongue. When the *pia* is injured, he thought there was loss of consciousness, loss of voice, pustules on the face, and, if the injury is severe, rigor of body which is a certain sign of death.

Ambrose Paré reported in the sixteenth century rather numerous observations of his cases of head injury. For example, one of these patients had

MANAGEMENT OF CRANIAL INJURIES

been unconscious fourteen days after having been hit on the head with a cannon ball! This man had vomited blood as well as having bled from the nose, mouth and ears, and also having had convulsive tremors—evidently an instance of fracture of the base of the skull with markedly increased intracranial tension. Paré trephined this patient and in his notes states that while he had operated, "God healed him and today he is still living." With all of our surgical progress since then, it is still quite an achievement to save a case of this kind, and there are certainly times when I suspect that influences other than ours have played the larger part. In 1559 Paré's master and friend, Henry II of France, was wounded by a lance blow in a tournament. The King lived eleven days. Surgeons could not find the lance splinters which had penetrated the brain, although they secured the heads of four criminals that had been beheaded, and experimented upon them to try to determine the probable course of the lance splinters. The King evidently died of a subdural hæmorrhage plus infection. Some of Paré's other reports are most interesting, but we must not let historical data delay us too long from the present day.

That versatile and great surgeon of the eighteenth century, Percival Pott, wrote a monograph on head injuries in 1759. He was an ardent advocate of early operation, and one finds cropping up in his opinions such statements as "the more pressing the symptoms are, the sooner the operation should be performed,—and all other attempts are worse than useless." Again—"Inflammation of the membrane always requires, and if slight, sometimes yields to large bleeding, gentle purging and a general febrifuge cooling regimes—even though perforation of the cranium should become necessary." In so far as fracture is concerned, he thought that unless there was a depression, there was no need for operation—that when infection occurred it was due to a "putrification" of the dura mater. He further states that fractures of the skull, considered abstractly, are not so dangerous a thing as they are commonly supposed to be. This fact, though stressed one hundred and seventy years ago, has been generally ignored since and until its repeated reiteration in the last few years. Pott advised that all gunshot wounds should be immediately trephined.

Abernethy in the early part of the nineteenth century must have been much interested in head injuries, and I have found the report of cases from his service at St. Bartholomew's Hospital quite interesting. He seems to have been as much of a conservative as his distinguished predecessor, Pott, was a radical. In beginning his report of cases, he states that while it had been largely the custom of the times, no doubt due to Pott's teaching, to trephine early, that in his experience "many cases have occurred of late where, even in fractures with depression, the patients have done well without an operation." He then reports in considerable detail five case histories to prove his point. Repeated bleeding, purging, saline medicines and antimonials were the treatment used in all of these cases—all showing fracture of the skull, some with depression and all with serious coincident brain

injury. These cases all recovered. Abernethy's comments are interesting: "It appears (he states) very clearly from these cases, as well as from a great number of others to be found in books, that a slight degree of pressure does not derange the functions of the brain for a limited time after its application. That it does not do so at first is very obvious, as persons are often perfectly sensible and free from headache and dizziness immediately after the injury. Whether it may not produce such an effect at some remote period is not so easily determined since this cannot be ascertained but by a continued acquaintance with the persons who had received the injuries." He continues, however, by stating that all whom he has had an opportunity of knowing for any length of time after the accident continued as well as before. He quotes Mr. Hill as substantiating this belief. Abernethy must have been fortunate in the cases he "followed up." Certainly it is contrary to the majority opinion of the present day that those who recover from serious brain injury remain entirely free from later trouble. I think it can be said safely that all know of instances of persistent headache, dizziness and even Jacksonian epilepsy occurring as sequellæ, regardless of the type of treatment at the time the injury was received, and immediately thereafter. In fact, the writer recalls hearing that wonderful teacher of a few years ago, John B. Murphy, state he would much rather die than to recover after having been unconscious from brain injury for more than five minutes. While this statement seems somewhat pessimistic, one is never justified in too great optimism that any given case of serious brain injury resulting in unconsciousness will entirely resume a normal life should immediate recovery follow.

Much more could be said on the historical side of this question. Many of the surgically great seem to have written something on the subject of head injuries. One can get a fair estimate, I think, of the practice of the times if the opinions of a few of these be considered as we have done. From Abernethy's time to the dawn of modern brain surgery twenty-five years ago, some progress was made, of course, but not of great moment as it has only been since then and more especially during the past ten years, that surgeons in general have had a better understanding of the underlying pathology of brain injuries. During the century that has elapsed, bleeding has gone and obvious skull injuries have been repaired where possible. Purging, however, has come back now on a more scientific basis. The advent of anæsthesia and asepsis has greatly increased the patient's chances.

There is still, however, and probably always will be, that irreducible minimum of immediately fatal brain injuries because, in spite of the centuries which have elapsed, and a certain increased storing with utilitarian knowledge, the brain is now the same as it was in the pre-Christian era. There is no axiom in surgical pathology more true than the one which states that the higher the degree of specialization of a tissue, the less is its power of regeneration! The tissues of the central nervous system, being the highest

MANAGEMENT OF CRANIAL INJURIES

of all, have none. Therefore, if certain vital brain centres are destroyed, life goes with them, and there is no help for such a situation. There is, however, that increasingly large group which fall between the immediately fatal and the trivial. All of the latter will get well, provided complications do not arise, and most of the intervening group should and do, under intelligent, modern management. These patients should not only get well, however, but if an intelligent plan of management is now used, should get well with a reasonable chance of staying well.

It is not easy to say just when the modern management of brain injuries began. A better understanding, at least, of such injuries seems to have gone hand in hand with the growth of modern brain surgery. For much of this progress, therefore, we general surgeons must give the credit to that especially interested group in the last twenty-five years—the neuro-surgeons.

It is perfectly apparent, of course, that one cannot outline clearly the management of an injury unless the underlying pathology of that injury is clearly understood. The difficulty of anyone, therefore, developing a rational plan of treatment of brain injuries during the centuries which have now elapsed, has been that until very recent years, a clear understanding of brain tissue reaction to trauma has not been definitely known. Even now we cannot say just what happens in the mild cases of concussion, since these cases almost invariably get well. My own better understanding of this matter, however, came with the work of Weed and McKibben, who, in the *American Journal of Physiology*, vol. xlviii, 1919, published the result of their experimental work on the alteration of brain bulk. They showed by direct observation of the brain in experimental animals, that hypertonic solutions of saline injected intravenously, certainly reduced the size of the brain, presumably by decreasing the fluid within the cranial chamber while, conversely, hypotonic solutions (water) injected into the veins, increased the size of the brain, presumably by the escape from the vessels of the watery element; further, histological changes within the brain cells were shown to have occurred where the increased tension was unrelieved—as for example, by trephining to allow more room for expansion—but these changes did not occur when such relief had been afforded. Since that time we ceased thinking of these injuries in the time-honored terms of *concussion*, *contusion*, and *compression* of the brain or *fractures* of the skull alone, and have since thought of them much more in the light of intracranial tension. These terms have been retained for clinical diagnosis since it has proven to be impossible to get surgeons in general to think of intracranial tension alone. In our own work, however, the latter was the keynote and gave the indications for proper management—as put forth in a paper on “A Plan of Management of Cranial Injuries Based on a New Grouping of Such Injuries,” read before this Academy in 1924, and published in the *ANNALS OF SURGERY* in April of that year. We began about that time to group our cases for the purpose of proper management into three groups, depending entirely on the presence or absence of increased intracranial tension as follows:

JOHN STEWART RODMAN

Group 1.—No increase in intracranial tension. Sub-group A.—Inevitably fatal. Sub-group B.—Mild concussion. Group 2.—Moderate increase in intracranial tension. Group 3.—Marked increase in intracranial tension.

I will not repeat now what has been said in that paper except that further experience since then with a much larger group of cases has in no way made me change my mind about the efficacy of the simple plan of handling these cases presented then—on the contrary, reducing this heretofore complicated question to a comparatively simple one has been of the greatest comfort to us and has, I am firmly convinced, definitely added to the success with which these cases have been handled. I do not mean to suggest that any grouping will change in one iota the result in some of these cases receiving serious brain injury at the time of the accident. Such fall into the inevitably fatal class in whom death ensues quickly and who do not last long enough to develop any increased intracranial tension—these die of shock plus probably a complete overwhelming of the medullary centres. In this type of case, treatment is of no avail. We classify all of those cases falling into this “inevitably fatal” sub-group who never recover consciousness—are inevitably markedly shocked—whose temperatures usually remain subnormal, although a rapid rise to hyperpyrexia is seen in some and whose pulse remains rapid and whose blood-pressure remains low. Incidentally, in such patients one can usually find evidence of fracture of the base of the skull on X-ray examination. Often there has been bleeding from the mouth, nose and ears and even the escape of brain tissue. Death ensues within a very few to twenty-four hours after the accident. All one can do is to treat shock. There is no need here to attempt to reduce intracranial tension since, as has been said, these patients do not last long enough to develop it. The literature on this subject has become enormous and as a result many clinical groupings have been proposed. All of them, however, recognize this inevitably fatal type of case for which little or nothing can be done. It would serve no useful purpose were it even possible to do so, to mention here the different ways in which many of those who have been interested in this subject, group their cases. Such groupings have no real value unless a definite plan of management can be built thereon. I do not wish to make any especial plea for the adoption of my own. To me it has been useful because I have been able to outline much more clearly what each case, as it comes along, shall have in the way of treatment. In the mild types of Concussion Group 1, Sub-group B (no increase in intracranial tension) the spinal pressure will be normal, and the clinical picture will be that of mild concussion. All of this type, unless complications ensue, will get well. The underlying pathology of this group must be imagined from what we know of brain tissue reaction to trauma. There is little more than a temporary anæmia, closely akin to ordinary surgical shock—the only difference being a transient loss of consciousness, or dazing, since the anæmia affects the medullary centres—when the anæmia has been recovered from, the blood-vessels will dilate again, and, as a rule,

MANAGEMENT OF CRANIAL INJURIES

the mentality will clear and remain so, unless the next step in brain tissue reaction to trauma is taken, namely, œdema. We do not find œdema occurring, however, in appreciable amounts until the case has progressed to Group 2 (moderate increase in intracranial pressure) with a spinal pressure reading of from 10 to 20 millimetres of mercury. These cases will show clinically, marked concussion, or even contusion with an increased period of unconsciousness, slow pulse and raised blood-pressure. If, when consciousness has returned, the patient is restless and lapses readily when undisturbed into sleep, we may fairly surmise that brain tissue has been minutely lacerated and minute hæmorrhage has added itself to the usual compressing force—œdema. In spite of treatment calculated to reduce this increased intracranial tension at times, the case will progress rapidly to Group 3 (marked increase in intracranial pressure) with a spinal pressure reading 20 millimetres or above. These cases will show the clinical picture of compression—unconsciousness lasting for days or even weeks, giving way to coma if the pressure be unrelieved, with a slow pulse later to become fast and weak, and with an elevated blood-pressure falling as the picture progresses toward a fatal termination. There is no need, in addressing this audience, to enlarge further on these separate pictures with which we are all familiar. So closely does the clinical picture fit the spinal-pressure reading, however, that we have given up doing it as a necessary step in the milder cases of concussion for diagnostic reasons.

The surgical management of any uncomplicated case falling into any of these groups is directed solely at relieving intracranial tension where it is increased. Since there is no increase in Group 1, Sub-group B, the simplest plan is called for—rest in bed three or four days, early and free evacuation of the bowels by magnesium sulphate enemas and a limited fluid intake will suffice, the latter two procedures being routinely done more with the idea of forestalling the development of œdema than of reducing it. In those cases falling into Group 2—to these measures will be added an intravenous injection of a 50 per cent. glucose solution (the latter having taken the place of hypertonic saline in our hands and *most others*) and possibly therapeutic spinal puncture, removing sufficient fluid daily to reduce the reading to slightly above normal, 12 millimetres on an average. In our group of uncomplicated cases, falling into Group 2, there was a small mortality. A greater death rate will, of course, be found in Group 3 (marked increase in pressure above 20 millimetres of mercury). To the plan of management already mentioned for Group 2, one must consider the addition of decompression. After having seen a great many cases since the beginning of this work on the above plan, I must confess to being still somewhat in doubt as to the wisdom of ever doing a subtemporal decompression. As a general rule, it will do no good in the cases which fail to respond to the non-operative plan already given—and yet there is the occasional case, progressing slowly toward the terminal stage of compression in spite of the most active non-operative plan that will, I believe, benefit by decompression. I have seen

JOHN STEWART RODMAN

such benefit a few times, but more often have been disappointed in accomplishing nothing. In such a case, however, no general anæsthetic is necessary and this simple procedure can do no harm. I intend to keep on doing it, though I believe it will only occasionally be thought of as a probable help.

With increasing experience, spinal tap has become with us more of a treatment than a diagnostic procedure. The character of the fluid means much as, of course, bloody fluid can only mean damage beneath the membranes and, naturally, makes the prognosis more grave.

I have referred to the "uncomplicated case" repeatedly. We have considered, in this plan, such frequent accompaniments of head injuries as laceration of the scalp, fractures of the skull, localizable intracranial hæmorrhage as complications in themselves, each with their own operative indication. There is no need to go into the matter further at this time as many papers have already done so, and I take it we are all agreed that such lesions usually call for surgical interference, except in the linear fractures of the vault or base. Again we shall repeat, however, that it is the injury to the brain which matters and to which we must direct our chief attack, and this means combating intracranial tension. I have not quoted most of the splendid original work which has helped in doing this, as those who have done it are well known to us, and have long since received the credit which they so rightly deserve.

These impressions have been based largely on seeing many of the 800 cases which have occurred on the surgical services at the Presbyterian Hospital since 1925. I am greatly indebted to Doctors Jopson, Hodge and Speese for making it possible for me to have done so. While the series does not include those cases seen prior to 1925 at the Presbyterian Hospital, nor those seen on my services at the Bryn Mawr and the Woman's College Hospitals, I felt that it was better for the purposes of this report to consider only this particular group occurring at one hospital since it is of sufficient size to warrant drawing conclusions from.

SUMMARY

Total number of cases studied.....	800
Group I (No increase in intracranial tension)	
A. Inevitably fatal	36
B. Concussion (mild)	578
Group II (Moderate increase in intracranial tension)	65
Group III (Marked increase in intracranial tension)	121
Total	800

Total mortality of series, 60 or 7.5 per cent.

	L.	D.	Per Cent.
Group I.....	604		
Sub group A.	0	36	100
Sub group B.	574	4	.7
Group II.....	65	59	6
	1024		9.2

MANAGEMENT OF CRANIAL INJURIES

	L.	D.	Per Cent.
Group III.....121	107	14	11.5
Mortality of those showing serious brain injury (Groups 1A, 2 and 3).....	166	56	25.2

(One case in every four in this series died of serious brain injury.)

CAUSES OF DEATH

Group I

A. Inevitably fatal.....	36 cases
(General and cerebral shock—brain laceration.)	
B. Mild concussion	4 cases
Pulmonary embolism	1
Terminal pneumonia	1
Hæmopneumothorax	1
Shock (multiple fractures)	1
	—
	4

Group II.....	6 deaths
General and cerebral shock—mild brain laceration.....	2
Peritonitis (simultaneous rupture of intestine)	1
Diffuse subdural hæmorrhage	1
Chr. alcoholism—terminal pneumonia	1
Hæmorrhage into left lateral ventricle and left internal capsule	1
	—
	6

Group III.....	14 deaths
(All died of brain compression)	

APATHETIC THYROIDISM

BY FRANK H. LAHEY, M.D.

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WE HAVE from time to time in the past few years spoken and written of a seldom mentioned and often unappreciated type of hyperthyroidism which we have termed apathetic thyroidism, in contradistinction to the typical hyperthyroidism of the activation type. In a clinic such as ours, where so many patients with thyroid disease are seen, many patients with this type of the disease remain undiagnosed for such long periods of time and when diagnosed are underestimated as to their seriousness because of their lack of activation, that we believe that a discussion of the differences and dangers of the two types may well be of value.

The diagnosis of frank hyperthyroidism of the typical activation type, particularly in the youthful (Fig. 1) is by no means difficult. Likewise the very obvious seriousness of the activation symptoms which characterize it compels a respect for its dangerous possibilities. One cannot see a patient with flushed skin, rapid, pounding heart, full, bounding pulse, rapid, ceaseless movements, high nervous tension, impressive emotional outbursts, and hot, moist skin, all contradicted by marked myasthenia, without being impressed with (1) the certainty of the diagnosis, and (2) the possibility of a fatal outcome upon the addition of any further burden on the increased intensification of the already existent hyperthyroidism. So outstanding are the diagnostic indications and obvious danger signals of activated hyperthyroidism that its diagnosis is rarely overlooked or its seriousness underestimated.

All that is so positive in activated hyperthyroidism, however, is negative in apathetic or non-activated hyperthyroidism. Activated hyperthyroidism is not necessarily limited, but tends to be so, to the middle-aged and youthful. Apathetic thyroidism appears almost entirely in those patients of middle age and past middle age (Figs. 2 and 3). Patients with activation hyperthyroidism tend to have either well-marked exophthalmos or very obvious stare. Those with apathetic thyroidism tend to have no exophthalmos and little, if any, stare.

Patients with the usual type of hyperthyroidism—that is, the activated type—tend to have glands of greater than normal size, although exceptions may occur in either type, while patients with apathetic thyroidism tend to have small, firm glands without striking increase in size.

Patients with thyroidism of the activated type tend to have pulse rates which are high and of full, bounding character. Those with the apathetic type of thyroidism tend to have relatively low pulse rates, varying from 100 to 120, and not characteristically full and bounding in character.

* Read before the Southern Surgical Association, December 11, 1930.

APATHETIC THYROIDISM

Patients with activated thyroidism show apex impulses which are thrusting and forceful in their type, while the apex beats in patients with apathetic thyroidism are not striking, distinctly not forceful, and obviously unimpressive in character.

The general motor activation of activated thyroidism is characterized by the rapidity of the motions and by the ceaselessness and wastefulness of their character. On the other hand, apathetic thyroidism is characterized by



FIG. 1.—Primary active hyperthyroidism. For purposes of comparison only, an activated type of thyroidism is presented. This is the exaggerated type of activation in a child of six with marked exophthalmos, with no weight loss, but with marked myasthenia; a history of hyperthyroidism of irregular course over a period of two years, a basal metabolism of plus sixty, a pulse rate of 128 to 132. A comparison of these two quite definitely different pictures of thyroidism will serve to illustrate how widely separated apathetic thyroidism is from that of the activated type.

very definite repose, reaching in many instances to a definite apathy which leads us to designate it by this term.

Activated thyroidism is characterized by a moist, hot, soft skin. Apathetic thyroidism, by a dry, firm, relatively cool skin.

Basal metabolism rates in activated hyperthyroidism are, as one would expect, usually proportionately high in relation to the degree of activation, +50 to +100, and over, while the basal metabolism in apathetic thyroidism is proportionately low in relation to the non-activation, as would be expected, +40 and downward to +20, and occasionally under.

Patients with activated hyperthyroidism tend to have had the disease shorter periods of time than do those with apathetic thyroidism, and those with the activated type of thyroidism acquire with it a certain indescribable youthfulness of appearance, while those with apathetic thyroidism have their appearance of agedness exaggerated until they seem unduly old for their actual years. This may be in some measure explained by the fact that the skin of patients with activated thyroidism tends not to be pigmented, but



FIG. 2.—Moderate apathetic thyroidism. This patient represents the moderately apathetic type of thyroidism with a quite typical history. She is forty-eight years of age. She has lost 85 pounds since 1915, her present weight being 88 pounds. She has complained of nervousness, weakness and palpitation since 1923. Her basal metabolism rate was plus thirty-nine. Her pulse rate during metabolism was 108 to 120. Her blood pressure was 130/80. Note that this patient in contradistinction to activation is in very definite repose. Note the absence of eye signs. Note the absence of any marked thyroid enlargement and note the senile appearance. It is to be noted also, as stated in the text, that the metabolism is not high and that the pulse rate is not high and that the weight loss has been progressive over a number of years.



FIG. 3.—Advanced apathetic type of hyperthyroidism. Goitre for twenty-five years. Weight loss of 52 pounds between 1925 and 1927. Metabolism plus thirty-six twelve days before operation; pulse 80-84; weight 105 pounds; blood pressure 150/0; auricular fibrillation and a large intrathoracic goitre. Note the lack of activation, definite apathy, dry and wrinkled skin.

possesses the live, warm, moist, pinkish flush which characterizes youth, as described above. The skin of patients with apathetic thyroidism, on the contrary, tends to be dry, cool, lifeless, and with the pigmentation which characterizes old age.

We have, unfortunately, had the opportunity to observe the behavior of individuals of both types during the onset of death following fatal reactions

APATHETIC THYROIDISM

to surgical procedures. Patients with activated hyperthyroidism die in states of distinct over-activation; those with apathetic thyroidism die in states of distinct apathy progressing into coma.

A fatal reaction following a surgical procedure in thyroidism of the activated type is associated with tremendous activation in all of its forms: cardiac (tachycardia up to uncomfortable rates), respiratory (very rapid respirations), motor (requiring restraint) and mental (up to delirium).

Patients with serious and fatal reactions following partial thyroidectomy for apathetic thyroidism go back to their beds and either never awaken from their anæsthetic, or awaken only to sink comfortably, leisurely, without activation, into semi-stupor or to become completely unconscious and die gently with practically none of those awesome activation signs which accompany death with the typical activation thyroidism, as, for example, seen in a young girl with intense exophthalmic goitre.

It is not my purpose to attempt to create another group in thyroid classification. We have all so simplified the classification of thyroid disease in recent years that it is much better understood and hence much better treated, and I do not wish to further complicate it. I do desire, however, to attempt to establish in the minds of physicians the existence of an atypical thyroidism of this type so that they may not overlook it in diagnosis because of its lack of obviousness, and so that they may not underestimate its unobtrusive but definitely certain seriousness.

As relates to its diagnosis, all patients with unexplained weight loss, unexplained tachycardia, unexplained myasthenia, should be investigated by careful clinical investigation and careful metabolic studies as to the presence of a possible apathetic type of thyroidism, regardless of the absence of any of the typical signs of hyperthyroidism. If physicians will have this atypical apathetic type of thyroidism in mind, we feel sure from our own experience with them that patients whose abnormal states were hitherto not infrequently undiagnosed, will be diagnosed as cases of apathetic thyroidism, submitted to subtotal thyroidectomy, and so be restored to health and relatively normal capacity.

It must, of course, be realized that there exist all gradations between the extremely intense and severe types of activated hyperthyroidism—for example, in a young and active child up to the extreme, almost somnolent type of apathetic thyroidism in an aged person. Fortunately, however, the two types tend to remain, from the very character of their differentiating signs, quite clearly separated, making thus their recognition not difficult when one has in mind the existence of this type of apathetic atypical thyroidism and has had experience with it.

It is very necessary that surgeons who are operating upon patients with thyroidism of this atypical apathetic type should realize the great capacity of patients with this type of thyroidism to die unexpectedly, giving few or no warning signs as to the impending fatality in their course upon the operating table.

Before we recognized and became familiar with hyperthyroidism of this apathetic type, we suffered the unfortunate experience of seeing an occasional unexpected fatality after subtotal thyroidectomy on patients with this condition, in spite of the fact that their course upon the operating table was anything but a disturbing one. Not infrequently patients with apathetic hyperthyroidism will maintain pulse rates upon the operating table during subtotal thyroidectomy of under 120, and without excessive pulse pressure. When these facts are associated in the surgeon's mind with the pre-operative observation that the patient's course pre-operatively has not been an activated one, and his basal metabolism rate has not been high, he is very likely to assume that subtotal thyroidectomy may unhesitatingly and immediately be undertaken with safety. By the same signs and line of reasoning, he is apt to assume, particularly due to the deceptively safe appearing course upon the operating table, that the entire operation can be done safely in one stage. It is in just such cases as this that unexpected fatalities arise. One should look rather to the pre-operative history of the patient and the recognition of the existence of this apathetic type of thyroidism to protect him against too early and too much surgery, rather than those striking danger signals of high pulse rates, high basal rates, high pulse pressure, and recent and excessive activation and intensification of the thyroidism which so characteristically accompany the typical patient with the activated type of hyperthyroidism and warn one of its dangers.

The particular danger signals in the patient with the non-activated type of apathetic thyroidism are marked weight loss, usually gradual and over a long period of time, in contradistinction to the rapid and extreme loss which characterizes activated thyroidism; the existence of the apathetic thyroidism for a long period of time, usually over a year; and an increase in the apathy which characterizes the disease.

We have been so impressed with the possibility of an unexpected fatality in patients with apathetic thyroidism that we have taken the position that the demonstration of the presence of apathetic thyroidism in a patient assumes that some good reason must be advanced why a two-stage operation, right and left thyroidectomy, should not be done. We have assumed the position that all patients with the apathetic type of thyroidism should have right subtotal thyroidectomy, should return home for six weeks, and then return for left subtotal thyroidectomy, with a few exceptions—for the most part patients in whom the disease has not existed for a long time, or there has either been no weight loss or the lost weight has recently been regained. We realize that this will result, in all probability, in some unnecessary two-stage operations, but since apathetic thyroidism carries with it no striking danger signals, but is still capable of serious atypical post-operative thyroid reactions which result fatally, this conservative operative procedure is necessary if we are to overcome the almost trivial operative mortality which still attaches itself to hyperthyroidism, and in our hands is largely related to patients with the apathetic type of thyroidism.

THERAPEUTIC FAILURES AFTER OPERATION FOR HYPERTHYROIDISM

BY JOHN ROGERS, M.D.

OF NEW YORK, N. Y.

EXCISION of a greater or less amount of the diseased thyroid is generally accepted as the best treatment for hyperthyroidism. The most reasonable explanation for the success of this operation (which, by the way, is not uniformly successful) involves an autoactivation and vicious circle hypothesis. The enlarged and overacting thyroid is supposed to produce a secretion which is in excess of the bodily needs, and this excess returns in the circulation to its source and stimulates the gland to continue indefinitely its pernicious activity. The operative reduction in the size of the gland, together with the necessary hæmostasis, cuts off both the excess of secretion and its access through the blood-vessels to the gland.

As the surgeon views his problems, there are three types of hyperthyroidism:

(1) That originating in a simple localized tumor or "toxic adenoma" without other appreciable enlargement of the gland. This group seldom or never presents exophthalmos, has little or no operative hazard, and has an excellent prognosis. But the majority of these patients are later subject to the vicissitudes of abnormal thyroid functionation, as are the other two groups. That is, they are generally of the type called "nervous," and when the organism is subjected to stress or strain the symptoms indicating hyper, or less often hypothyroidism, become manifest. As these patients are familiar with the abnormal sensations, if they recur they generally come back for treatment before any goitre has appeared.

(2) Hyperthyroidism from more than one toxic adenoma. If palpation and inspection show that the gland tissue which intervenes between the tumors is approximately normal in size and consistency, the simple enucleation or excision of the tumors will prove nearly as satisfactory as the enucleation of a single toxic adenoma. But if there is a general enlargement of the gland in addition to the tumor formation, especially if exophthalmos is present (and this is rare), the prognosis becomes less certain.

(3) Hyperthyroidism resulting from a diffuse or general enlargement of the entire gland. In this group, at least in the early stages of the disease, there are no evidences of localized tumor formation. This occurs later. The surgical indications are generally accepted as removal of the enlarged isthmus with resection of enough of each lobe (together with the necessary hæmostasis) to abolish the excess of secretion and still leave sufficient secretory tissue to perform the evidently vital functions of the gland. The most approved, because the least dangerous, technic begins the operation with

division and elevation of the isthmus and attached lobes from the trachea. This obviates the traumatism to the posterior part of the gland which is involved in turning each lobe out by a finger inserted behind it. The prognosis of this group is much less certain than in the other two. In my experience it has a close relationship to the size of the goitre, and the presence or absence of exophthalmos. There is, in addition, to be considered the duration and severity of the hyperthyroidism and its complicating lesions. Exophthalmos occurs in about one out of ten of these cases. Its cause and mechanism are, of course, unknown, but its degree of development seems more or less proportionate to the gravity of the outlook. If the operation proves successful, the exophthalmos seldom disappears before the expiration of two years.

Hyperthyroidism, with a large goitre, on the other hand, as a rule seems to have a better surgical prognosis than that with a small "goitre." Incidentally, the word "goitre" should be restricted to actual pathological conditions of the thyroid, and should not be applied to the simple soft hypertrophy without other symptoms so common in youth and which is apparently an enlargement to compensate for the bodily needs.

These three groups of hyperthyroidism, or (1) the single, and (2) multiple toxic adenoma, and (3) the diffuse hyperplasia of the gland, show a tendency to merge into one another. That is, the thyroid containing a single toxic adenoma may develop one or more other tumors, and at the same time there is usually but not always an enlargement of the intervening glandular tissue. Or the primary diffuse enlargement may have one or more nodules form within it. It is exceptional for the goitre to enlarge after the development of hyperthyroidism. But in the history, the "goitre" is generally the first symptom noted and the hyper syndrome comes afterwards. Occasionally, however, this course of the disease is not apparent, and the hyperthyroidism develops with little or no goitre. This is sometimes actually the case, but more often at least some thyroid enlargement can be detected. This seems to mean that the usual progress of events, or first hypertrophy of the gland, and later its "overactivity," cannot take place. There is some mechanism which should provide for the primary hypertrophy, and this mechanism is lacking in the group of hyperthyroid patients who are the most difficult to cure and who most commonly relapse, or after the usual radical operation develop neuroses which lack the hyperthyroid characteristics. A troublesome anæmia is a not infrequent sequence.

Before citing examples of these observations, it is advantageous to review the little that is known about the physiology of the thyroid. Much can, and should, be inferred from clinical experience. The meaning, for example, of the most common sequence of events, or first hypertrophy of the gland and then hyperthyroidism, should probably be interpreted as a progressive failure in function. Each stage apparently represents an attempt at compensation. There is no doubt that a deficiency of iodine in the ingesta

THYROIDECTOMY THERAPEUTIC FAILURES

can cause an enlargement or hypertrophy of the thyroid. This happens, not always but often enough to prove that iodine is an important factor in the change. It is not the only one, because the administration of iodine after the hypertrophy has occurred seldom causes it to disappear. This primary hypertrophy is generally accepted as an automatic attempt at compensation. That is, when the product of the thyroid is inefficient because of a lack of iodine in the alveolar epithelium, these cells multiply and the entire organ enlarges to support their proliferation. This change generally seems sufficient to support the bodily needs for the thyroid product, because in the majority of instances, after the gland reaches a certain size, the hypertrophy ceases and a so-called "simple goitre" persists indefinitely (but may at any time overact). As long, however, as it remains a simple hypertrophy without the development of fibrous or adenomatous tissue, it enlarges by becoming congested whenever the organism requires any increase in the activity of its epithelium. This regularly occurs during menstruation, or during the expenditure of effort which may be voluntary or involuntary, as during an infection or after traumatism or cerebral excitation (nervous strains).

If the primary hypertrophy, which may be due to iodine deficiency, is not adequate for the bodily needs, the next stage in the process should show a more rapid epithelial proliferation, and the infolding of the alveoli, and this change is generally regarded as characteristic of hyperthyroidism. It seems to represent an attempt at compensation which "goes" wrong. The automatic demand for the thyroid product results in an excessive product which is presumably deficient in its iodine content because of the manifest benefit which follows the administration of iodine. The mechanism by which these morphological and physiological changes are brought about is, of course, unknown, but the underlying and general nature of the disturbances seems to me evident.

Where, however, the thyroid enlarges and then overacts without any demonstrable lack of iodine in the ingesta, the process cannot be essentially different. Iodine is still important, as shown by the beneficial effects in hyperthyroidism. But the evidence still points to a primary defect in the quality or quantity of the thyroid product and the hypertrophy (which may not occur) and the later overactivity are in all probability attempts at compensation. In this hypothesis the assumed "weakness" of the thyroid, as shown by its primary hypertrophy and later "overactivity" (when it is not due directly to a lack of iodine in the ingesta), may be congenital as is strongly suggested by the not infrequent familial occurrence of the disease. One should be able to inherit a weak thyroid like a weak brain; a congenital weakness is evident in cretinism, or the weakness might be acquired in many ways. For example, a weakness in organs which, experimentally, support or are functionally associated with the thyroid, like the pituitary or adrenals or others, adds to the complexity of the problem but at the same time shows how the thyroid "weakness" might be acquired. If it can be accepted

that the hyperthyroid gland is primarily a weak and inefficient organ and not one which is viciously overacting and so should be ruthlessly sacrificed, much can be gained. Mutilating operations can at least be avoided, especially in hyperthyroidism with a small rather than a large goitre.

The usual operative procedure is "subtotal thyroidectomy." But this should not be too literally applied, especially when there is little or no goitre. The gland seems to have a marvellous capacity to regenerate, but when it is too much reduced in size it may, and apparently often does, functionally fail. That is, the hyperthyroidism does not cease after operation and the organism continues to show the evidences of thyroid overactivity. The symptoms are not infrequently altered from their original character, but remain distressing and disabling, and are very difficult to relieve. Therefore, the safest operative rule in the presence of a small or absent goitre is to reduce the blood supply as far as possible, and if resection is attempted to make it fulfil the same purpose (reduction of blood supply), and remove only enough of the thyroid tissue to leave the organ approximately normal in size (and this is really a small organ).

The causes which produce the manifestations of the apparent thyroid "weakness" or hypertrophy, and later "overactivity," or overactivity without the preceding hypertrophy, are also debatable, but should not be so obscure when there is considered the accepted and principal treatment of all thyroid abnormalities, namely, rest. Fatigue always intensifies, and rest alleviates the symptoms. Fatigue involves a preceding active metabolism, and the thyroid product is known to be concerned in the metabolism of practically every organ in the body. Infections, or traumatism, or rapid growth, or active cerebration with its reflections upon the viscera through the involuntary nervous system, are among the general causes which should and apparently do originate activity in the general metabolism, and should cause a "weak" thyroid to hypertrophy and eventually to "overact." Hence it is reasonable to regard fatigue in its physiological sense as the ultimate cause of both enlargement of the gland and hyperthyroidism.

As regards "cerebration," or "mental strain," as a cause of the disturbance, it is generally recognized that the "nervous" type of individual is more or less predisposed to the disease. A "nervous" personality is only one which responds to environment with more than the usual expenditure of energy. One who is "nervous" therefore must require active metabolism, and the "weakest" organ in the chain upon which this depends should be the first to fail. In "nervous" men, this seems most frequently to be the stomach, and the result is manifested by gastric hyperacidity and pylorospasm, and later gastric ulcer. "Nervous" women seem more commonly to develop hyperthyroidism. There are many close analogies between these disorders, and not the least is the evident involvement of the involuntary nervous system, and its psychological association with the emotion of fear. In one form or another it is at the bottom of worry, anxiety, excitement or grief which is so commonly present in the history of the origin or beginning of

THYROIDECTOMY THERAPEUTIC FAILURES

hyperthyroidism (or pylorospasm and many other neuroses of the involuntary system).

This may or may not have to do with the adrenals and their functional failure with that of the thyroid. However this may be, and whatever part the involuntary nervous system may play in the hyperthyroidism, the surgeon should assume the presence of a weak or inefficient thyroid, no matter how much it may appear to "overact." The gland, therefore, should not be reduced in size beyond that which was the original or healthy normal, and if relapse occurs after operation, unless a reappearance of hypertrophy of the gland is manifest, a secondary radical operation has a dubious outlook. Medical treatment, with rest as its chief ingredient, combined with iodine and organ therapy, and a large admixture of "tincture of time," are more promising.

The following case histories illustrate some of the above observations.

CASE I.—Miss M. L., aged twenty-two, during a strenuous college life noted a slight, right-sided thyroid enlargement (no palpitation). Later after examinations she developed "palpitation" and the pulse rate was found to be 100-120, metabolism plus 20 to plus 30. Goitre just perceptible on the right side. In July, 1919, the right lobe and isthmus of the thyroid were excised with some lessening of the tachycardia, but the asthenia persisted. In November, 1923, there was still inability to do any work. There were insomnia and "shakiness," a pulse rate of 76-140. Metabolism of plus 10. Scar of a "collar" incision. No perceptible "goitre."

During 1923, 1924, 1925, various thyroid preparations were administered, and the best results were finally obtained with a mixture in equal parts of a glycerine extract of thyroid and adrenal. This seemed to gradually relieve the weakness and nervous irritability, and during 1928 she began to perform the duties of a part-time teacher.

In 1929 there was considerable improvement, but she could not endure even a moderate day's work without the aid of the glycerine extract of thyroid. Any other preparation produced tachycardia.

In 1930 there is still persistent the asthenia and nervous irritability. While in bed and at rest, no physical abnormality can be detected. But when up and about "effort tachycardia," with dyspnoea, is evident.

The symptoms all date from the hyperthyroidism which occurred in 1919. Previously, she could be called robust but of a nervous temperament. Hence, it is reasonable to regard the symptoms as due to a defect in what can be called the "driving chemistry" of the nervous system, and the primary cause is evidently a defective thyroid.

This is a typical example of many similar therapeutic failures. They occur most often when the disease develops during adolescence or early youth, apparently, after a combination of strenuous mental and physical effort, and with a small rather than a large "goitre." No matter whether the existing final abnormality is called psychasthenia, or neurasthenia, or neurocirculatory asthenia, it is traceable to the same defect in the nutrition of the nervous system, which in turn is evidently dependent upon a weak thyroid.

CASE II.—J. D., aged thirty-eight, salesman, after strenuous work, developed a small goitre in 1918, but no tachycardia (hypothyroidism).

In 1919 (first operation) the development of exophthalmos, tachycardia and nervous irritability forced operation. The right, or larger, lobe was excised, and after some

JOHN ROGERS

improvement during the next month he resumed work. Recurrence of the symptoms followed.

In 1920 (second operation) he submitted to excision of the isthmus and part of the left lobe. After resting three months with considerable gain he returned to work and again relapsed.

October, 1928, typical Graves' disease, with marked exophthalmos. Small, hard remnant of thyroid, apparently the lobus pyramidalis, on right side of thyroid cartilage, and small hard remnant perceptible on left side. Pulse rate 100-120. Metabolism plus 30. Good general nutrition.

November, 1928 (third operation), both inferior thyroid arteries (quite large) tied. Considerable improvement followed. Medication consisted of 1 grain of iodide of iron daily, and 10 minims of a glycerine extract of adrenal. This seemed to control the rather frequent bowel movements. He then attempted to resume work and again relapsed.

March, 1930 (fourth operation), the enlarged remnant of the thyroid on the right side (lobus pyramidalis) was excised. Exploration revealed an apparently posterior remnant of the right lobe. Then the left lobe, about two inches long and an inch thick and very vascular, was resected to leave about the normal amount of tissue. Convalescence was uneventful, and he resumed part-time work after two months of rest. He is now working moderately, but seems dependent upon a 1 grain iodide of iron pill daily, and a mixture in equal parts of glycerine extracts of thyroid and adrenal.

September, 1930, slight exophthalmos. No goitre. Pulse rate 80-120. Metabolism plus 10. Iodine with the glycerine extract of adrenal and a small amount of a glycerine extract of thyroid seem essential to maintain strength enough for even a moderate amount of work.

In each of the operations the goitre could be accurately described as *small*. Benefit followed each resection which at least reduced the size of the gland to such an extent that it was not externally perceptible. It became perceptible only after the resumption of work (compensatory hypertrophy).

CASE III.—Miss N., aged forty, nurse, after a long period of strenuous night duty suffered from extreme fatigue and noted a goitre which was just perceptible (hypothyroidism). Rested and improved, but after another period of strenuous nursing, developed evident but moderate hyperthyroidism.

In 1917 (first operation) both superior vessels were ligated, and the tachycardia subsided. Shortly after resuming work the hyperthyroidism became again manifest.

In 1918 (second operation) the right or larger thyroid lobe was excised and tonsils removed. Complete recovery followed. After three months she resumed work, and the hyperthyroid symptoms again recurred.

In 1925 (third operation) the left lobe of the thyroid, which was just perceptible, was resected. After resting six months she felt well, but on resuming work she again relapsed.

June, 1928, slight exophthalmos, no perceptible goitre, pulse rate 110-120. Weight 120 pounds. Hemoglobin 40 per cent. metabolism plus 30. Fair general condition. It seemed useless to operate, and she was given a 1 grain iodide of iron pill once daily, and a mixture in equal parts of the glycerine extracts of thyroid and adrenal. A slow improvement followed.

October, 1928, the weight had increased 20 pounds, and the pulse rate varied between 80 and 120, and the hemoglobin was 60 per cent. She resumed nursing duty but seemed dependent on the combined thyroid and adrenal feeding. Without it she became too weak to work.

December, 1929, came to the hospital after a period of rather strenuous nursing

THYROIDECTOMY THERAPEUTIC FAILURES

work with a fibrillating heart and almost uncountable pulse. Hæmoglobin 30 per cent. Red cells 1,240,000. After two weeks, both the hæmoglobin and red cells had become less and the blood picture showed distinct pernicious anæmia. Lilly's Liver Extract was then added to the thyroid and adrenal feeding, and improvement rather rapidly followed.

September, 1930, hæmoglobin 90 per cent. red cells 4,700,000, pulse rate (irritable) 80-120, systolic blood-pressure 140, weight 132. She is now taking one tubule thrice weekly of the Lilly Extract, and daily the glycerine extracts of thyroid and adrenal, and is again attempting to work and seems normal in health.

CASE IV.—Miss A. N., aged seventeen, has grown nearly 6 inches in the last eighteen months, and during this period developed a "goitre." Menstruation began at twelve years of age, but stopped when the goitre appeared (hypothyroidism?). During the last six months has noted palpitation and recently some exophthalmos (hyper).

December, 1926, very large, well-developed girl (5 feet 10 inches in height), slight exophthalmos, moderate, soft, vascular goitre, neck circumference $15\frac{1}{4}$ inches, pallid but flushes easily, moist skin, pulse 120-140, weight 170 pounds, metabolism plus 40.

December, 30, 1926.—Novocaine anæsthesia. Both inferior thyroid arteries (very large) tied through a vertical incision behind the lower end of the sternomastoid muscles.

January 7, 1927.—Ethylene anæsthesia. Resection of the thyroid beginning at the isthmus and leaving each lobe a little larger than normal. Histological report of the specimen was "typical of Graves' disease."

March, 1927.—Perfect recovery, except for a perceptible exophthalmos. "Goitre" not visible. Neck $14\frac{1}{2}$ inches. Pulse rate 76.

November, 1927.—Resumed school work and showed a gradual recurrence of hyperthyroidism.

February, 1928.—Typical Graves' disease again present. Pulse rate 110-120. Goitre enlarging, neck $15\frac{1}{4}$ inches. Metabolism plus 30. Rest in bed, with 1 grain iodide of iron pill once daily and 10 minims of a glycerine extract of adrenal three times a day, produced marked improvement.

June, 1928.—Again practically normal. But after a rather strenuous social summer relapse occurred.

November, 1928.—Typical Graves' disease again. Considerable but soft goitre, neck $15\frac{1}{4}$, pulse rate 120. Five X-ray treatments were administered over the thyroid (combined with rest and iodine and adrenal feeding which previously had been ineffective) produced rapid improvement.

September, 1930.—No evidence of any thyroid abnormality. Goitre has disappeared.

This history shows the effect upon the thyroid of rapid growth and the beneficial influence of X-ray treatment over the gland. In the soft, hyperthyroid goitre, especially when the symptoms are of short duration, this agent is often of remarkable benefit; but the patient must be warned about "overstrain," that is, must be fully aware of so-called "physical limitations," or relapse can be expected. This seems to mean a thyroid which is not competent to promote more than a limited amount of the general metabolism. This does not deny that if the gland is protected or "helped out" for a long enough period it may and probably will become normal.

CASE V.—Miss B. A., aged twenty-three, stenographer. After a period of strenuous work, with little sleep, noted a small goitre (hypothyroidism), and some weeks later was troubled with palpitation and then was aware of "staring" eyes.

April, 1923.—Slight exophthalmos. Easily perceptible small firm goitre, pulse rate 120, weight 100, metabolism plus 30.

JOHN ROGERS

Operation consisted in the ligation of all four thyroid vessels, in two stages. This was followed by great improvement, but after resuming work two months later, there was a rather severe tonsillitis and exacerbation of hyperthyroidism. The goitre, which had nearly disappeared, immediately enlarged.

In December, 1923, the tonsils were found "chronically infected." Exophthalmos had recurred. The pulse rate was again 120 and metabolism plus 40.

February, 1924.—Infected tonsils removed. This was followed by an almost immediate improvement in the hyperthyroidism, and after three months of rest the same strenuous mode of life was resumed.

October, 1925.—Reports in apparently perfect health. The exophthalmos and the considerable firm goitre had both entirely disappeared. There had been a gain in weight of 25 pounds.

The most striking feature was the alteration in the structure and functionation of the thyroid. Before the tonsillitis it had only been perceptible; afterward it had become large and showed signs of increasing activity. Then, excision of the spongy, chronically infected tonsils had resulted in a more or less rapid disappearance of all the thyroid symptoms, including the considerable and rather hard goitre. The cause and the effect seem obvious.

Judged from a therapeutic standpoint, the simplest form of hyperthyroidism seems to be that due to a single toxic adenoma. If there is no other gross enlargement of the gland, the enucleation of the tumor will more or less rapidly and without appreciable danger cure the symptoms. But many, if not the majority, of these patients are subject later, under conditions which put stress upon the general metabolism, to the vicissitudes of abnormal thyroid functionation. Hence, many of these patients who present a toxic adenoma seem to have primarily a "weak" gland. The tumor does not usually recur (if one is not overlooked at the primary operation). It can be supposed to originate as a punctate hæmorrhage in the substance of a "weak" gland which has become congested in some attempt at functionation. This smaller or larger hæmorrhage into the substance of the thyroid is not very uncommon, and sometimes causes the sudden development of a painful tumor which is easily (?) differentiable from an abscess. But if the hæmorrhage is minute it might be the focus of irritation around which the proliferating tissues could form an adenoma. However this may be, the gland which appears grossly normal outside of the adenoma should be regarded as "weak" and, therefore, should be disturbed as little as possible. Enlargement of the gland is often apparent with a single toxic adenoma, yet if it is slight, simple enucleation of the tumor is generally curative.

Many of these adenomata show just outside of their capsule a narrow area in which the alveoli have the characteristics of the hyperthyroid gland. Elsewhere these changes are absent, or the alveoli are simply larger than normal. In these cases the post-operative asthenia is generally persistent and can be relieved and convalescence shortened by thyroid feeding preferably with the glycerine extract of thyroid. Only when the toxic adenoma is accompanied by a noticeably diffuse hypertrophy of the gland is it necessary to consider (in addition to the enucleation) resection of the organ.

THYROIDECTOMY THERAPEUTIC FAILURES

Whenever there is doubt, ligation of the accessible vessels is preferable. It conserves presumably valuable tissue.

There may, however, be two forms of the single toxic adenoma, one originating, as suggested above, in a "weak" gland, and another being a truly toxic, benign neoplasm which is analogous to the tumors of the parathyroid or pituitary or adrenal or even of the Islands of Langerhans. Instances of tumors of these organs, with the symptoms of excessive functionation of their characteristic cells, have not infrequently been reported. After excision of the tumor the symptoms disappear. Corresponding tumors of the thyroid should occur. These might be the cause of the "thyroid heart" which of late has been much discussed. These patients usually present a dilated and fibrillating heart with its associated lesions and symptoms, but show very little of the usual hyperthyroid signs, and the metabolism is somewhere near that which should be expected from the heart condition. The clue to the origin of the disturbance can be found in perhaps a small localized tumor in the thyroid. After its excision, which is comparatively simple and safe, the heart and the associated lesions usually return more or less rapidly to normal. May not these true toxic adenomata of the thyroid, when they do not end prematurely in a cardiac death, be the common origin of the carcinomata which are supposed to originate most frequently in a benign tumor of the gland?

The following history illustrates the unrecognized toxic adenoma with serious heart complications:

CASE VI.—Miss B. S., aged fifty-one, teacher, had been ill many years, first with gastric symptoms—for which gastroenterostomy had been performed—then with "heart disease."

In October, 1927, she was emaciated, and though 5 feet 7 inches in height, weighed only 71 pounds. The heart was dilated (apex in the anterior axillary line), very irregular in action, pulse rate uncountable at the wrist. The legs were œdematous. The liver and spleen were slightly enlarged. In the course of the examination, a small tumor, apparently in part calcareous, was found in the right lobe of the thyroid. This, she said, had been present many years. The left lobe and isthmus were imperceptible. It did not seem possible that this partly calcareous thyroid adenoma was the cause of the heart condition, and the treatment was medical for three months. She left the hospital in December, 1927, much improved.

In October, 1928, she returned in a slightly worse condition than the year previously. There was extreme emaciation, diarrhœa and a dilated and fibrillating heart with an uncountable pulse rate. Weight 71 pounds. Metabolism plus 30. After rest in bed for two weeks, under ethylene anæsthesia, the left lobe and isthmus appeared normal. The right lobe, which consisted of an ovoid adenoma about 1½ inches long and 1 inch thick, was excised. The upper half of the tumor was calcareous, the lower half showed the structure of a "thyroid adenoma." Recovery was uneventful. At the end of a week the heart, with the aid of digitalis, showed a nearly normal action. At the end of a month she left the hospital, and in June, 1929, there was no sign of any abnormality, and there had been a gain in weight of 60 pounds.

It seemed incredible that such a small and partly calcareous adenoma should have caused so much damage, and that the heart could have again become normal.

JOHN ROGERS

The following history illustrates a toxic adenoma which occurs in a weak thyroid:

CASE VII.—Mrs. T., aged forty, hard-worked mother of four, had suffered from numerous nasal and tonsillar infections, and finally a vaginal repair and appendix operation. A few weeks afterward she noted a small tumor in the right lobe of the thyroid, and later began to feel tachycardia. There were the usual hyperthyroid signs: a two-inch globular dense tumor in the right thyroid lobe; pulse rate 110-120.

December, 1919.—A cystadenoma was enucleated under novocaine anaesthesia from the right thyroid lobe. The remainder of the gland appeared normal. Recovery within ten days. Pulse rate 76.

October, 1921.—After a strenuous month with sick children returned with complaints of being weak, tired, nervous and wakeful. No goitre. Pulse rate 100.

November, 1921, after two weeks in bed, and 5 minims of a glycerine extract of thyroid three times daily, the pulse rate and general health were normal.

May, 1923, after a strenuous social winter there was headache, nervousness, asthenia and insomnia. No goitre. Pulse rate 80-100. Glycerine extract of thyroid again relieved all the symptoms.

April, 1924.—She sustained a Colles fracture of the right wrist and much pain as proper treatment was unobtainable for three days. After reduction of the fracture and splinting, the thyroid could be palpated for the first time since operation. There were complaints of a "lump in the throat," with headache and asthenia. Pulse rate 80. Glycerine extract of thyroid again relieved all the symptoms, and when the splints were removed the thyroid enlargement had disappeared.

June, 1929, again after a winter of strenuous social life, there were complaints of an aching, "choky" throat, asthenia, headache and insomnia. No goitre. Pulse rate 76. Glycerine extract of thyroid promptly relieved the symptoms.

The following history illustrates a fatal therapeutic failure with multiple toxic adenomata:

CASE VIII.—O. M., aged forty-nine, factory superintendent, first noted a "goitre" as a lump on the right side five years ago after work and worry in the settlement of a strike. During the next two years other nodules appeared, coming after "labor troubles." Then palpitation, sweating, weakness and insomnia followed.

December, 1925.—Physical examination showed good general nutrition, pallor, multiple thyroid adenomata, largest on the right side, scattered throughout both lobes. Pulse rate 90-100. Systolic blood-pressure 140, weight 156. Metabolism was plus 30. After a month of rest, with a 1 grain iodide of iron pill daily, there was no appreciable improvement.

January, 1926, under ethylene anaesthesia, a large substernal adenoma was turned out on the left side and trimmed away, with enucleation of several adjoining nodules and preservation of as much apparently normal tissue as possible. Many adenomatous nodules were then excised from the right lobe. After suture of the remnants of thyroid, and ligation of both superior vessels, each lobe was approximately normal in size. At the close of the operation the general condition seemed excellent, and pulse rate was 80. *Histological report.*—Colloid adenoma of the thyroid.

January 15, or twelve hours later, pulse rate and temperature began to rise, and restlessness and delirium appeared.

January 16, 7 A.M.—Pulse 160, temperature 104°, respiration 40. Delirious. Minims 30 of a non-coagulable aqueous extract of thyroid ("Thyroid Residue") given by hypo every two hours.

January 16, NOON.—Pulse 130, temperature 102°, respiration 30. Delirium less, much improved. Thyroid administration stopped.

THYROIDECTOMY THERAPEUTIC FAILURES

January 16, NIGHT.—After 3 P.M., pulse rate and temperature began again to rise, and were not checked by thyroid hypodermatically. Patient died in coma about 6 A.M.

This history of multiple toxic adenomata is reported to show the probable significance of the dangerous or fatal reaction which may follow extensive mutilation of the diseased gland. In this instance the many tumors were scattered over or through tissue which, in the gross, appeared more or less normal and so worthy of retention. The excision or enucleation of the tumors, however, required much traumatism of the apparently sound tissue and, consequently, its function must have been suppressed. The result was a fatal post-operative toxæmia which, at the outset, seemed to be relieved by the subcutaneous administration of a non-coagulable aqueous extract of the thyroid ("Thyroid Residue"). Later this treatment failed. I, as well as others, have reported many instances of the dangerous post-operative "toxæmias" which seem, by the administration of a thyroid extract, to have been saved from impending death. There is at least one report in the literature of a similar success with thyroxin, but I have not dared to use it, chiefly because of its slow effect. The inference to be drawn from these experiences is that the toxæmia is not due to a sudden increase of the "poisonous" (?) thyroid product; the traumatism inflicted upon the secreting cells should suppress and not increase their function. It is more reasonable to believe that the sudden failure of the alveolar epithelium deprives the nervous system of some essential nutritive element and it reacts accordingly. It is probable, therefore, that in advancing hyperthyroidism there is a progressive failure in the nutrition of the central nervous system, and the nerve cells contain no reserves. Consequently, when the inadequate thyroid support is suddenly withdrawn these cells fail. The toxæmia terminates in a coma not unlike that of diabetes. It suggests a nervous starvation rather than a toxæmia. If there were available for hypodermatic use the normal product of the thyroid, the acute thyroid toxæmias could all probably be saved. Thyroxin is undoubtedly a very active derivative of the gland, but experimentally it does not seem to quite fulfil all of the functions of the gland. It acts upon the sympathetic system, and is capable of "sensitizing" it, whatever that may ultimately signify. Aqueous or alcoholic extracts of the entire thyroid, however, seem to stimulate the vagus and, clinically, in early typical hyperthyroidism, the vagus, or parasympathetic system, rather than the sympathetic is most active. It is possible that the advancing thyroid toxæmia is due to an increasing amount of thyroxin in the thyroid product and a decrease in some unknown but vitally important other conjoined material (?).

In these histories a 1 grain iodide of iron pill has been given once daily in conjunction with a glycerine extract of thyroid, or a glycerine extract of adrenal. Sometimes the thyroid and adrenal have been combined. The 1 grain iodide of iron pill (ferrous iodide) of the National Formulary contains approximately 0.8 grains, or 52 milligrams, of iodine. Twenty

minims of the more commonly used Lugol's solution contains about 2.5 grains, or 156 milligrams, of iodine. If this (20 minims of Lugol's solution) is administered constantly in hyperthyroidism, there will be an occasional acute exacerbation of the disease which seems then to mean that the epithelium of the thyroid alveoli is too "weak" to metabolize such an amount of iodine into colloid. For the latter is absent in the toxæmic gland and in its place the alveoli are filled with a mass of disintegrating cells. To be sure, nothing is known about the relationship of the colloid material to the actual product of the thyroid; but the absence of colloid and the presence of severe toxæmia at least suggests that the thyroid is not performing its function. Its normal morphological elements are lacking and, therefore, it is not poisoning the nervous system by functioning too much. If the colloid material represents the secretion of the gland (and there is a general agreement that it does not) the colloid is absent. On the other hand if it is some intermediate product, as seems probable, then the disintegrating cells in the alveoli are manifestly not this intermediate product and the nervous system is "starved."

A toxic adenoma, however, apparently poisons the heart, probably through its nerve supply. But, as in Case VI, the central nervous system is not appreciably affected. It does not show the peculiar irritability of the usual hyperthyroidism.

A 1 grain iodide of iron pill once daily, with its comparatively small iodine content (and about 19 per cent. of iron) seems never to show the occasional dangers of the usual large dose of the compound solution of iodine and is much simpler to "take," and also provides the slightly questionable benefit of the iron. Many of these patients show some anæmia. There are many reports in the literature which show that a very small dose of iodine in hyperthyroidism is as effective as a large dose, and also is preferable.

There is no doubt of the beneficial effects of thyroid feeding in pronounced hypothyroidism, or myxœdema, yet there is no knowledge as to how or where it or any other organ therapy acts. The usual medicament is a desiccated product containing a standardized amount of iodine. Even a minute amount of this material may intensify the symptoms of these "post-operative therapeutic failures" who are afflicted for a long period with asthenia and effort tachycardia. Being convinced that the primary fault in these cases was essentially a hypothyroidism, I have experimented with all the available thyroid preparations, and have found that a glycerine extract (one of the earliest products used in organ therapy) seems the least toxic and the most generally beneficial. It is made by mixing equal parts of glycerine and hashed fresh pig glands. After straining, or filtering, off the coarse particles, 5 minims of the nearly clear liquid contains approximately 0.04 milligrams of iodine. This medication is employed at first in a dosage

THYROIDECTOMY THERAPEUTIC FAILURES

somewhat smaller than 5 minims, and gradually increased as the tolerance is established.

Several years ago I supervised some experiments which seemed to prove that the feeding of adrenal material increased the iodine content of the dog's thyroid. Adrenalin did not. With this hint, I administered in hyperthyroidism in conjunction with iodine some preparation of the adrenal, preferably a glycerine extract of the entire gland. It seems particularly useful when there is activity of the gastro-intestinal tract, such as abnormal hunger and frequent bowel movements. It is also useful in combination with iodine and a small amount of the glycerine extract of thyroid in the presence of an irritable rather than a constantly fast pulse rate. This represents the common post-operative asthenia with an "effort tachycardia." A glycerine extract of the adrenal prepared like the similar thyroid extract contains approximately 0.14 milligram of adrenalin in 10 minims of liquid. These preparations are available commercially in 5 and 10 minim pills.

During the incipient stages of hyperthyroidism, and especially during the post-operative recovery, many of these patients complain bitterly of a feeling of pressure or constriction in the region of the thyroid. It bears some resemblance to a spasm of the œsophagus, and has in several instances cited in the literature been demonstrated as such (by radiography). For the relief of this symptom, a combination in equal parts of glycerine extracts of thyroid and adrenal is very useful. X-ray treatment of the gland for hyperthyroidism is generally regarded as useless. But in the early stages of a post-operative recurrence it may be curative, as in Case IV. It may also stop the tachycardia in a beginning hyperthyroidism with a small soft goitre. But to be effective it must always be supplemented by preventive and supporting treatment.

SUMMARY

Hyperthyroidism probably represents an attempt at compensation which "goes wrong." It usually begins with a simple hypertrophy of the gland. The thyroid promotes the metabolism, and so the functional or cellular activity of practically every organ and tissue in the body. It performs this function through an iodized secretion made by the alveolar epithelium. In the hyperthyroid condition of the gland there is a multiplication of these cells. Iodine generally decreases this proliferation, but sometimes increases it. The epithelium thus seems to vary in its vital capacity or ability to metabolize iodine. If the secretion is inefficient from lack of iodine, or from lack of the vital capacity to metabolize it, the gland is "weak" and should hypertrophy to compensate for the bodily needs which are expressed automatically through the blood or nerve supply, or both. These needs are activity in any one or more organs, and the effect is that of fatigue or its biochemical equivalent. The normal response of a "weak" thyroid to promote this production of energy is a multiplication of the alveoli and their

JOHN ROGERS

epithelium. If this proves inefficient to meet the bodily demands there is a more rapid proliferation of the epithelium, with a resulting hyperthyroidism. If the normal preliminary hypertrophy is slight or absent this phenomenon should represent an additional unknown factor of "weakness" in the thyroid. Consequently, under these conditions, extreme operative reduction in the size of the gland is of doubtful value.

The purpose of operative interference is to reduce the quantity of secretion and, at the same time, to check the apparent autoactivation of the gland. The latter is the most reasonable explanation of at least some of the effects of thyroid feeding (autoactivation).

The immediately post-operative functioning of the thyroid should be conserved by gentle manipulation of the unexcised portion.

The convalescence, which is often prolonged, needs constant supervision to avoid fatigue, or its physiological equivalent in infection or emotional strain. The thyroid should also be supported by a small amount of iodine to check the epithelial proliferation, and by (experimental) organ therapy to support the "weak" gland; thyroid (when the resting pulse rate is normal) or adrenal (to help the weak alveolar epithelium to metabolize the iodine), or possibly pituitary or ovarian preparations.

RESULTS OF THYROIDECTOMY

ANALYSIS OF ONE HUNDRED CASES

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FROM THE BUFFALO THYROID CLINIC

THYROIDECTOMY as the best treatment for hyperthyroidism is being challenged in many quarters today¹ and the results claimed for it vary widely, all the way from 18 per cent.² to 92 per cent.³ of cures. Careful and unprejudiced study of the post-operative results, therefore, is needed to clear up this question. Complete pre-operative examination and careful preparation of toxic goitre patients by qualified groups and carrying out of the operative procedure by teams trained in the handling of these cases has reduced the mortality of thyroidectomy to the point where that procedure is no less dangerous to life than medical treatment, radiation, or no treatment at all. The only question that remains, therefore, is which form of treatment offers the best chance of complete and permanent cure.

In this study we have taken 100 consecutive thyroidectomies during the period ending three months ago and compared the pre-operative condition with that found three months later. It is, therefore, a study of the immediate results of thyroidectomy only. We have confined ourselves in this way because our records are almost complete in these cases. It is our intention to follow this group through the coming years and report the final results later. We have taken all thyroidectomies, because the boundary line between non-toxic and slightly toxic goitres is a very indefinite one and to place cases into the one group or the other brings in the personal element. Neither have we separated the toxic adenomas and exophthalmic goitres, because of the confusion that exists regarding their relationship and because most pathological thyroids contain a combination of various histological pictures.

Having thus made the selection of our group entirely impersonal, we have carried out the same principle in our post-operative examinations, using as the basis for our comparisons tests that are not influenced by personal opinion, namely, the pulse, the weight, and the basal metabolism. In addition to these three tests, we have also taken into consideration the patients' own statements as to their nervousness and their general state of health, because even with favorable objective findings, a patient is not cured unless she herself is satisfied and feels good.

Under this latter head would be included most of the subjective symptoms, such as pressure symptoms, shortness of breath, dysphagia, weakness and palpitation.

Taking first the pulse rate, we find that three months after operation

ALFRED H. NOEHREN

it had decreased in seventy-one, increased in twelve, remained stationary in eleven, with no records in six cases (Fig. 1). The average pulse before operation was $104\frac{1}{2}$, three months after operation it was 87. Of those that remained stationary, all were 85 or less before operation. Thus we

DECREASED	71
INCREASED	12
STATIONARY	11
NO RECORDS	6

FIG. 1.—Pulse three months after operation.

have only 12 per cent. to 13 per cent. that did not show a decreased or a continued normal pulse three months after operation.

A similar condition was found in the weight of these patients (Fig. 2). Sixty-seven patients gained an average of 9 pounds, twenty-one remained stationary, while nine lost an average of 6 pounds (one lost 22 pounds), with no records in three cases. Here again, all who remained stationary

GAINED	67
STATIONARY	21
LOST	9
NO RECORDS	3

FIG. 2.—Weight three months after operation.

had not lost weight before operation except two. Thus only 11 per cent. did not show a gain, or continued normal weight three months after operation.

A parallel condition was found in the basal metabolic rates (Fig. 3). Sixty-eight patients showed a decreased rate after three months, nine remained stationary, fourteen showed an increased rate, with no records in nine cases. Before operation, the average rate was $+30$, the highest being $+80$, the lowest -23 . Three months later the average rate was $+8$, the

DECREASED	68
STATIONARY	9
INCREASED	14
NO RECORDS	9

FIG. 3.—Basal metabolism three months after operation.

highest being $+70$ (see second unimproved case below), the lowest -18 . Again all but one of those who remained stationary had a normal or near-normal rate before operation. We see, then, that only $15\frac{1}{2}$ per cent. did not show either a decrease or continuance of a normal rate. Incidentally we found the lowest rate after operation only -18 , showing that no serious hypothyroidism followed subtotal thyroidectomy.

Going now to the statements of the patients themselves, first, as to their nervousness, second, as to their general condition, we find the following. Before operation, six patients said they were not nervous, two slightly

RESULTS OF THYROIDECTOMY

nervous, forty-seven quite nervous, and forty-five very nervous (Fig. 4). Three months after operation, sixteen reported no change, forty-six said

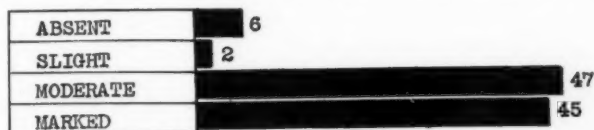


FIG. 4.—Nervousness before operation.

their nervousness was less and twenty-three said that it was much less, with no records of fifteen (Fig. 5). In other words, not a single patient re-

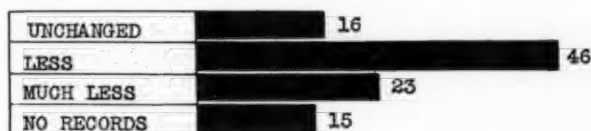


FIG. 5.—Nervousness three months after operation.

ported her nervousness worse, while sixty-nine reported improvement and sixteen no change in three months.

Finally, we have analyzed what the patients themselves think of their condition. While this may not be a strictly accurate way of judging the results of thyroidectomy, nevertheless it is most important. The most complete cure as measured by tests and figures is of little use to the patient if she does not think that she is better. I have divided the patients into

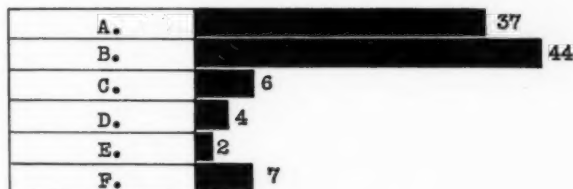


FIG. 6.—General condition three months after operation.

five classes: A, those who report a "perfect result," "feeling fine," "can't find superlatives," etc.; B, those "feeling good," "good recovery," "O.K.," etc.; C, improved; D, very little improvement; E, no improvement. (Fig. 6) shows the number in each of these groups.

Dividing the cases into two groups, those that improved and those with very little or no improvement, we find that 93½ per cent. of those recorded



FIG. 7.—General condition three months after operation.

belong in the former and 6½ per cent. in the latter group, with no records in seven. (Fig. 7.)

ALFRED H. NOEHREN

An analysis of the six cases that showed very little or no improvement follows:

The first case was the only operative death in the hundred patients, representing 108 operations, 8 having been done in two stages. This patient, a woman of forty, had a very toxic adenomatous goitre and developed a marked post-operative reaction, complicated by a collapse of the trachea, necessitating tracheotomy. Death occurred on the second post-operative day.

The second patient was a woman of sixty with a very toxic adenomatous goitre accompanied by some mental disturbance. Unilateral subtotal thyroidectomy was done, she made a good operative recovery, and was sent home to await improvement before removing the other lobe. There was no improvement, however; she continued to lose weight; her basal metabolism remained at +70; finally she refused to take nourishment, became maniacal, and died about six months after operation.

The third patient was a man of forty-five with a somewhat latent toxic adenomatous goitre. His pulse was 84 and regular, but his basal metabolism was +51 and he had lost 17 pounds in weight. During the operation, his pulse became very rapid and only one lobe was removed. He was sent home and placed on the usual post-operative treatment under the care of his doctor, but at the end of three months he still had a very rapid, irregular pulse and his basal metabolism was +59, although he was feeling better and had gained in weight. We are hoping to get him into a little better condition before removing the other lobe.

The remaining three patients suffered from very toxic exophthalmic goitres. The one, a Polish girl of twenty, had a unilateral thyroidectomy done, but had such a severe reaction that it was considered best to send her home for six months, with definite instructions as to rest, diet, etc., which she promptly proceeded to disregard. On a visit a few days after leaving the hospital, she was found in the midst of a hilarious birthday party.

The second, a young man of eighteen, also of Polish parentage, had a bilateral subtotal thyroidectomy done in two stages and was sent home with similar instructions as in the preceding case. He, too, promptly proceeded to disregard them and inside of one month married, although strongly advised against it.

The third patient, a girl of sixteen, had a bilateral subtotal thyroidectomy done, followed all instructions faithfully, but nevertheless showed only slight improvement at the end of three months. We are hoping that her improvement is merely delayed, as has occurred in a number of our cases not in this series.

Thus we see that of the six unimproved cases, two are probably due to the patients' refusal to coöperate and in two others we are looking forward to later improvement. In all six cases we feel sure that neither medical treatment nor radiation nor a combination of the two would have accomplished any better results, except in the patient who died after operation. She, of course, would have lived a little longer, but in all probability would not have been cured.

Summing up these various findings, we come to the following conclusions:

1. In a series of 100 consecutive thyroidectomies, representing 108 operations, examined three months after operation, 93 per cent. report either satisfactory improvement or complete cure.

2. This percentage is verified to a considerable extent by three objective tests as follows:

- a. An average pulse rate of 104½ before operation was reduced to 87

RESULTS OF THYROIDECTOMY

after operation and 87 per cent. of the patients showed a reduction or continuation of a normal pulse rate.

b. Sixty-seven patients gained an average of 9 pounds, while nine lost an average of 6 pounds after operation and 89 per cent. either gained weight or continued a normal weight.

c. An average basal metabolism of +28 before operation was reduced to an average of +8 after operation, while 84 per cent. showed either a reduction or continuance of a normal basal metabolic rate.

3. Taking all factors into consideration, we would place the percentage of cures three months after thyroidectomy somewhere between 80 per cent. and 90 per cent.

4. A study of these cases over a longer period of time may show a recurrence in some, but may also show improvement in some of those that did not improve after three months.

5. With an operative mortality of 1 per cent. and a cure of 80 to 90 per cent. in three months, thyroidectomy seems to offer the best chance of cure in most cases of goitre.

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BILATERAL EMPYEMA OF THE PLEURAL CAVITIES

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MEDICAL progress since the late war has been remarkable for the triumphs of the thoracic surgeon. Profiting by a rare circumstance which combined the necessity of treating large numbers of severe war wounds of the chest with that of treating even greater numbers of empyemas, he has produced an abundance of excellent work which has revolutionized and radically improved, among other things, the treatment of empyema. His successes are reflected in practice by the more intelligent care of empyema, and in the literature by the appearance of excellent articles upon the subject.

One phase of the subject of empyema, however, has stood apart from the stream of investigation and discussion like some small hamlet untouched amid the changes of a great world. This phase is bilateral empyema. Its occurrence is much less rare than many text-books would indicate. Its severity tends to be exaggerated. Its treatment is sometimes undertaken with a hesitancy that is the complement of unfamiliarity, while the principles of treatment are not always clearly understood. Hence any attempt which may stimulate renewed interest in this subject is not likely to be futile.

Such an attempt has been made here in the form of an outline of the natural history and treatment of the disease based upon forty-one case reports and guided by a review of the literature. The forty-one cases include one case* personally observed at The New York Hospital and two other unpublished cases† from the same hospital; also thirty-eight cases collected from the literature of the past ten years. The review of the literature briefly summarizes the partial reviews of Scanlan¹ in 1928 and Bozzotti² in 1913, and brings up-to-date and abstracts the more thorough monographs of Mackenzie³ in 1914, Fabrikant⁴ in 1911, and Hellin in 1905⁵ and 1907.⁶

Natural History of Bilateral Empyema. Definition.—The term "bilateral empyema of the pleural cavities" denotes a condition in which pus is found in both pleural cavities at or about the same time.

Bilateral empyema is usually considered a complication of unilateral empyema. It is almost always acute, very rarely chronic.

* The author takes pleasure in an expression of his indebtedness to Dr. Eugene H. Pool for a suggestion which inspired this work.

† One of these cases is from the First Surgical (Cornell) Division of The New York Hospital and is included by permission of Dr. James Morley Hitzrot.

BILATERAL PLEURAL EMPYEMA

Incidence.—About 7.7 per cent. of all empyema cases are bilateral according to Hellin⁵ who found that 113 of 1,448 empyema cases showed involvement of both sides. Lower figures are usually given. Thus, Lord⁷ in Osler's "Modern Medicine" quotes 2.0 per cent., or 5 out of 248 cases; Geitz⁸ records 0.8 per cent., or 5 out of 588 cases from a review of twenty-three Swedish hospitals; while my figure is 0.6 per cent., or 3 out of 495 cases at The New York Hospital from 1914 to 1930. Standard text-books, if they mention the subject at all, usually agree with Da Costa⁹ in saying "in civil practice I have seldom seen it." Graham,¹⁰ however, observes that empyema "is bilateral in probably less than 5 per cent. of . . . non-fatal cases."

For children, Holt and Howland¹¹ call empyema "bilateral in about 3 per cent. of all cases, but oftener in infants."

The incidence during the epidemics of influenza of 1917 to 1919 was very high. Dunham¹² found it to be 42 per cent. in the United States Army Camps in 1917, or 253 out of 603 empyemas. Stone's¹³ figure was 19 per cent. at Fort Riley for the winter of 1917-1918; he observed 19 out of 100 empyema cases. Likewise with other epidemics of influenza the incidence may be high; thus Mackenzie³ saw many cases during an epidemic near Portland, Oregon, in 1899.

Age.—The average age is eleven and one-half years. Extremes of eight months and sixty years were reported by Fabrikant.⁴ About 75 per cent. of cases occur before the twelfth year.

Sex.—Males predominate over females by 3 : 2.

Primary Disease.—The most frequent cause is pneumonia; it preceded 75 per cent. of cases. Three-quarters of these pneumonias were bronchopneumonias. "Primary" bilateral empyemas accounted for 20 per cent. of Fabrikant's cases.⁴ One of the cases of this series might so be classified (Case 26).

The rarer causes are pyæmia, tuberculosis, actinomycosis and the exanthemata. Surgical operation or its complications may also precede. Very interesting is the epidemic of puerperal sepsis which was followed by many cases of bilateral empyema described by Charrier¹⁴ in 1855; the occasional cases recorded since have been collected by Hellin⁵ and Fabrikant.⁴

Bacteriology.—The pneumococcus is the usual causative organism. It was cultured from the pus of twelve patients of this series. The hæmolytic streptococcus, however, almost invariably accompanied the post-epidemic influenzal cases. A variety of other organisms may be present.

Rarely a different organism is obtained in the two sides, as with Case 39.

Pathology.—The pathology does not differ from that of unilateral empyema.

Pathogenesis.—The involvement of the two sides rather than one may be accounted for in part by a preceding pneumonia of the two lungs, and this was true of twenty-one cases of this series. An increase of virulence of

the infective organism may also be a factor as was indicated by the high incidence accompanying the wartime influenza epidemic. On the other hand, there are patients whose lowered resistance is a predisposing cause, as illustrated by Cases 40 and 41. Occasionally empyema of both sides follows pneumonia of one lung (Cases 30, 31 and 40). Here the empyema of the other side possibly arose from a pneumonia so slight as to be overlooked, or possibly by metastatic infection. The cases of "primary" empyema are very difficult to explain.

Why should not bilateral pneumonia more often be followed by empyema of both sides? Certainly the majority of the pneumonias of both lungs which are succeeded by empyemas are succeeded by an empyema confined to one side. It may be that most pneumonias mature with unequal rapidity on the two sides so that the antibodies from the first empyema are sufficient to prevent a contralateral empyema.

The time of appearance of the two empyemas may be simultaneous, as shown by Cases 31, 32 and 41; or not, as Cases 33 and 39 illustrate. In Case 33 almost two months intervened.

Diagnosis.—Diagnosis presents no unusual features, and it will be correctly made more often if the condition be borne in mind.

Complications.—These are similar to those of unilateral empyema.

Prognosis.—The mortality was 37 per cent. for Fabrikant's series of 118 cases.⁴ It is 19.5 per cent. for this series, but this figure is of little significance as it omits all the numerous deaths of 1917 to 1919.

The prognosis should be influenced greatly by the type of the infection. Thus many patients with the pneumococcic type recover, whereas there is no record of recovery of a single individual with the streptococcus hæmolytic type. Failure to make this distinction may have influenced certain authors, Heuer¹⁵ for example, to classify all bilateral empyema "among the fatal cases of empyema." However, cases following influenza are by no means necessarily fatal. Thus, Mackenzie³ saw at least three during the Portland epidemic of 1899 (Cases 6, 7 and 8), while Cafritz¹⁶ and Beck¹⁷ successfully treated influenza cases, the latter that of a pregnant woman (Case 25).

Treatment. (A) General Principles.—The general principles of the treatment do not differ from those of unilateral empyema, and may be found thoroughly discussed in any of the principal works on chest surgery¹⁸ written since the late war. A brief note on current practice must suffice here.

(a) Maintenance of the nutrition of the patient by high-fluid and calorific intake is very important; for empyema is sometimes like typhoid, a long wearing disease.

(b) Obliteration of the empyema cavities is to be accomplished by drainage and reëxpansion of the lungs. Thoracotomy with rib resection is often necessary, though intercostal drainage alone may suffice. The patient may hasten reëxpansion by using blow bottles. Secondary operations to promote drainage or to prevent chronicity may be required.

BILATERAL PLEURAL EMPYEMA

The drainage tubes should not be permanently removed until the empyema cavities have become obliterated as shown by physical signs and by röntgenograms, and until discharge from the wound sinuses has become slight in amount and sterile.

Drainage should be deferred if possible until the pus within the pleural cavity has become thick, thoracenteses being employed meanwhile. Thus intrapleural adhesions will have time to form, and the pneumonic process to subside. Streptococcic empyemas must not be drained as early as pneumococic and other types of empyema.

Rarely, repeated thoracenteses may cure a bilateral empyema.

(c) Avoidance of open pneumothorax is a measure of great importance. It should be attempted by using drainage of the closed type; in other words, by drainage which maintains a negative intrapleural pressure. After some days the closed may be changed to the open type.

(d) Sterilization of the empyema cavity may best be accomplished by frequent irrigations with some solution, such as solution of chlorinated soda (Dakin's). The solution if kept warm will avoid heat loss from the lung.

(B) *Particular Application.*—For discussion, let us assume that there is a patient having bilateral empyema of similar extent and duration on the two sides. Let us further assume that by application of the principles outlined above a decision has been reached that it is time for drainage. The question immediately arises as to whether to drain both sides simultaneously or not.

To this question many writers have in the past answered "No" because of the fear of bilateral open pneumothorax. They have based their fear upon the assumption, prevalent up to the ending of the late war, that an open pneumothorax of both sides would be followed by collapse of both lungs and consequently by death.

Investigations carried on during and since the late war, particularly those of Graham and Bell,¹⁹ have shed new light on the pneumothorax problem and on the treatment of empyema. They have shown that the mediastinum of normal individuals is so flexible that it will readily transmit smaller pressure changes from one pleural cavity to the other; in other words that the chest may be considered practically as one instead of two cavities in so far as intrapleural pressures are concerned.

They have also determined that there is a certain area of opening into the pleural cavity, 51.5 square centimetres, which is the maximum compatible with life if the thorax is normal and if the individual's vital capacity equals 3,700 cubic centimetres (a common average figure for the vital capacity). This is so because of a definite relationship between the amount of air entering the lungs and that entering the pleural cavity. Openings into the pleural cavity smaller than 51.5 square centimetres are increasingly well borne. It is to be understood, however, that the above deductions were made with reference to the normal thorax. If the mediastinum is stabilized

by adhesions or by induration, then a unilateral opening of much larger size than the one mentioned may be made. On the contrary, if no such stabilization has occurred and if the patient's vital capacity is low (*e.g.*, 1,000 cubic centimetres) because of pneumonia, or other reasons, then a much smaller pleural opening may be fatal. Since it is the area of opening and not the number or position of the openings that is of importance, similar openings into each pleural cavity will have no more ill effect than a single opening into one pleural cavity of twice the area.

Experience has justified these theoretical conclusions. Many soldiers with surprisingly large open wounds of both chest cavities survived. Moreover, eleven patients with bilateral empyema²⁰ have been operated upon by simultaneous thoracotomies on both sides. No patient died as a result of the operation; one patient collapsed temporarily but was resuscitated, and another died twelve days later from a cause not attributable to the operation. Furthermore, forty-two other patients²¹ were operated upon by almost simultaneous thoracotomies, that is to say by thoracotomies performed on the two sides within twenty-four hours of each other. None of these patients died, and all eventually recovered. Thus, a total of fifty-three simultaneous, or nearly simultaneous, thoracotomies has been performed without a single operative death, and with eventual recovery of all but one patient.

Bilateral simultaneous thoracotomy for bilateral empyema, then, has proved itself an excellent method of treatment. This will be more apparent when it is observed that all the above simultaneous thoracotomies were performed under the open method, hence under conditions less favorable than would have prevailed under the safer closed method. Certainly simultaneous or nearly simultaneous closed thoracotomies should be more extensively used in future. It is also notable that many patients are very little relieved after the first thoracotomy; they tend to remain very little changed until after the second thoracotomy when they often show sudden and remarkable improvement, as was the experience with Case 39 and others of this series. Delay in opening the second side, therefore, seems to accomplish little, but rather to weaken the powers of resistance; another reason for the simultaneous method.

If for some reason it is decided not to drain simultaneously, there arises the question as to which side is best for the initial operation. The left side has usually been preferred because of the belief that the heart would thereby gain greater freedom of action, and that pericarditis would be less apt to occur. These are worthy considerations. Concerning the likelihood of pericarditis Dunham²² says that "there is no marked difference in the relations of the pericardium to the pleura on the two sides of the chest, and pericarditis has occurred at least as frequently with an empyema on the right side as with one on the left."

If the empyemas are quite unequal in extent, the larger should be drained

BILATERAL PLEURAL EMPYEMA

first; but again, let it be repeated that the second side should be drained very soon thereafter. In the interval thoracenteses are usually beneficial.

CASE I.—(Personal observation.) A girl of two years, Jewish, was admitted to The New York Hospital, December 18, 1928. *Family History.*—Three of the ten brothers and sisters were dead before the age of four years of pneumonia, meningitis, and diphtheria. *Previous history.*—One year before admission there had been an operation for abscess of the right thigh, the operation being complicated by pneumonia

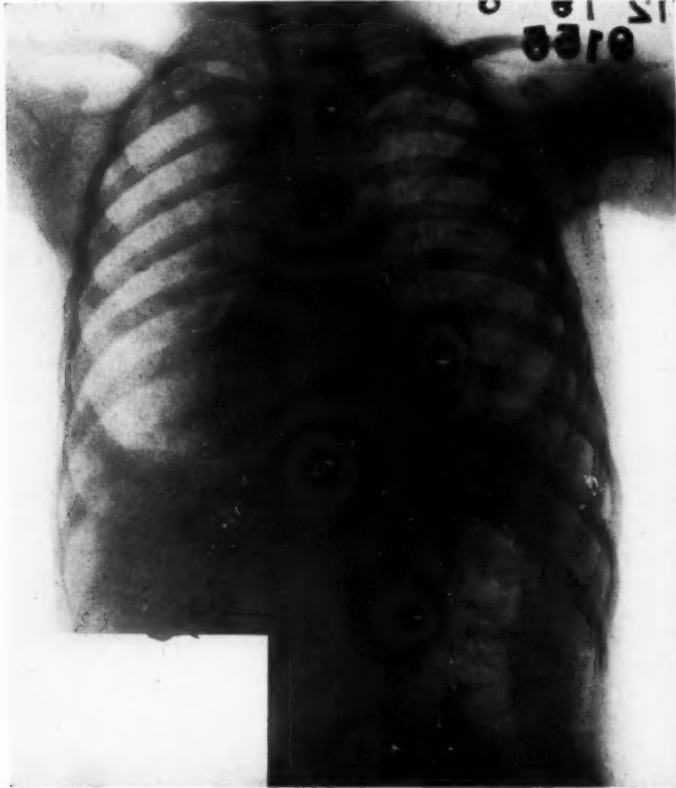


FIG. 1.—Chest roentgenogram of the case observed personally (Case I—Case 41 of table) taken the day after admission, December 19, 1928, showing beginning effusion at the right and possibly the left base and early bronchopneumonia. This report and the three that follow are by the late Dr. Webster W. Belden, of The New York Hospital.

and diphtheria. Thereafter the gait was limping. *Present illness.*—The mother stated that fourteen days previously, December 4, the child had caught cold, and later coughed and had a chill. The family physician found the child to have a high fever, and put her to bed. There was considerable improvement for a week, but thereafter a relapse. The coughing increased, and much thick yellowish material was expectorated. Finally the child became drowsy. *Physical examination.*—On admission the child appeared very sick and emaciated. The temperature was 100.2 degrees Fahrenheit. Respirations were rapid and grunting, and there was a frequent non-productive cough. The chest was symmetrical and equally expansile. Both *lungs* showed dullness posteriorly up to the angle of the scapula; the left axilla also showed dullness. Breath sounds, voice sounds, and fremitus were unchanged from the normal. The *heart* was percussed $5\frac{1}{2}$ centi-

E. LAWRENCE KEYES

metres to the left of the midsternal line in the fifth interspace. The pulse rate was 110 to the minute, the rhythm regular. The leucocytes were 12,400 per cubic millimetre with 83 per cent. polymorphonuclear leucocytes and 17 per cent. lymphocytes. The urine was normal, and other findings normal.

A *diagnosis* of bilateral bronchopneumonia and bilateral acute empyema was made. It was confirmed by röntgenogram on December 19 (Fig. 1) which revealed pleural effusion at both bases and bronchopneumonia. Thoracenteses three days after admission (December 21) yielded thick greenish pus from both pleural cavities. *Cultures* from both sides showed a pneumococcus type I. A total of 80 cubic centimetres of pus was withdrawn from the right side, and an amount unrecorded from the left. Seventy cubic centimetres of pus were withdrawn from the left side the next day. Little improvement followed. The child lay propped up in bed, semicomatose and cyanotic, struggling to breathe and to cough. It was now or never for drainage; moreover, six or more days of waiting after onset of the empyema seemed time enough to render opening the pleural cavity relatively safe. It was decided to drain the right side first because of the preponderance of pus in the right chest. Physical signs showed displacement to the left of the heart and trachea, while the signs of fluid extended on the right as high as the spine of the scapula posteriorly, and to the third rib anteriorly in the midclavicular line; whereas on the left they extended only to the angle of the scapula posteriorly, and were absent anteriorly. Meanwhile it was hoped that repeated thoracenteses would take care of the left side.

Accordingly *operation* for closed drainage of the right pleural cavity was performed December 24. With the patient seated the operative field was prepared by application of a half-strength solution of tincture of iodine. A preliminary thoracentesis at the operative site yielded thick pus. After infiltrating the overlying skin with 1 per cent. procaine a small incision was made in the eighth right interspace in the posterior axillary line and carried down to the parietal pleura. A No. 22 French catheter was then seized in a Kelly clamp and plunged through the unopened pleura into the pleural cavity. Thick pus immediately flowed through the catheter which was clamped off in order to maintain closed drainage. The soft tissues and skin were then approximated closely about the catheter by silk worm sutures passed through an encircling cuff. The operation lasted ten minutes and caused no reaction.

With the patient removed to the ward a drainage-irrigation apparatus was arranged. The end of the catheter, which protruded from the wound, was connected by a glass Y-tube to two other tubes, a drainage tube and an irrigation tube. The drainage tube was carried under the bed to a glass receptacle and its end kept under water. The irrigation tube led up to a bottle of irrigating solution hung at the head of the bed, and was kept clamped off except when in use. Before removing the clamp from the catheter which protruded from the wound all the tubing was filled with a solution of chlorinated soda (Dakin's), and all air excluded. After removing the clamp negative pressure was thus immediately exerted on the empyema cavity.

The tubes were irrigated three times a day by allowing to flow through them about 10 cubic centimetres of the solution of chlorinated soda from the bottle at the head of the bed. When clogged by pieces of exudate, as often happened, the apparatus was disconnected, and the protruding catheter irrigated by manual suction with a syringe until all obstructions were removed. During this procedure the protruding catheter was never for a moment left open except while being subjected to negative pressure. Then, after cleaning the apparatus it was reconnected. Responsibility for the apparatus and its proper working rested with one house officer.

The amounts of pus drained day by day varied greatly. No accurate measurements were made, but some days at least 100 cubic centimetres were returned. On one occasion 70 cubic centimetres of pus were withdrawn through a syringe within a few minutes. As a rule manual drainage proved more efficient than mechanical arrangements for the

BILATERAL PLEURAL EMPYEMA

removal of pus and exudate. Large clumps of whitish-yellow fibrinous matter were often obtained; the pus or exudate bore some resemblance to curdled milk.

Slight improvement in the condition of the patient followed operation. The temperature ranged between 100 and 101 degrees, sometimes reaching 103 degrees. The nutrition remained poor. Fluids were forced. A transfusion of 200 cubic centimetres of whole blood was given (December 26). The left pleural cavity was tapped repeatedly; December 26, forty cubic centimetres of pus were obtained; January 1, forty, and January 3, only eight.

The right pleural cavity was reported free of fluid by a röntgenogram of December 31, seven days post-operatively, but the left chest still showed haziness and mottling.

Closed drainage was replaced by open on the eighth day after operation (January 1). The catheter was removed and a soft open rubber tube put in its place.

The patient's condition was becoming steadily worse. While not so sick as just before the first operation she still did not appear to be very far from death. Examination revealed a rather extensive bronchopneumonia of both sides added to the left empyema. The wound on the right continued to drain moderately.

Since the right lung was well expanded it was decided to open the left side. The twelfth day post-operative, therefore (January 5), operation for closed drainage of the left pleural cavity was performed. The technic employed and the after care were similar to that already described.

Immediate and continued improvement followed operation. The temperature gradually subsided to normal. The child was allowed up after the twenty-seventh day post-operative, the temperature never exceeding normal limits thereafter.

The closed drainage of the left side was changed to open on the fourth day post-operative by removal of the catheter and insertion of a soft rubber tube into the wound.

The drainage tubes were retained in both sides until the thirty-third day after the second operation (February 7) when they were finally removed.

Röntgenograms of the chest after the third day following the second operation (January 8 and 16) showed both pleural cavities free of fluid and both lungs completely expanded and clear.

The patient was discharged cured April 4, 1929, about four months after the onset of illness. She had gained much weight and was in excellent physical condition. Both wounds were completely healed. There were no abnormal physical signs in the chest, and no cough.

The condition was entirely satisfactory when seen in the Follow-Up Clinic July 7, 1929.

CASE II.—A boy of seventeen was admitted to The New York Hospital May 18, 1918. The *family history* and *previous history* were irrelevant. *Present illness*.—The patient was taken with pneumonia of the right lung April 29, 1918, which spread to the left lung on May 4. The family physician made a diagnosis of pleurisy of both sides, the right more marked. *Physical examination*.—The day of admission the patient appeared emaciated and acutely sick. The temperature was 102.4 degrees, Fahrenheit, pulse 126, and respirations 34. The right chest lagged during inspiration. The right lung showed flatness below the angle of the scapula with diminished breath sounds; anteriorly there was flatness below the level of the nipple and diminished breath sounds with ægophony and pectoriloquy at the level of the nipple. The left lung showed impairment of percussion, and a few coarse râles below the angle of the scapula. The urine was normal and the examination was otherwise normal. A provisional *diagnosis* of empyema of the right pleural cavity was made.

At operation the next day open drainage of the right pleural cavity was performed. Gas oxygen anæsthesia was employed. A needle was inserted in the eighth interspace, posterior axillary line, and pus obtained. One and one-half inch of the eighth rib was

E. LAWRENCE KEYES

then resected. After opening the pleura a large empyema cavity was revealed. Two rubber tubes were inserted for drainage. Culture from the pus revealed streptococcus viridans.

Following operation there was moderate improvement. A röntgenogram seven days later (May 26) showed a thickened right pleura and right pneumothorax, but no fluid in the right chest. The wound did not drain well so exploration of the wound was done ten days after the first operation (May 29). Under gas-oxygen anaesthesia a finger was passed into the cavity through the wound, but no pocketing was found. A drainage tube with suction, closed drainage, was applied, and following operation the cavity was regularly irrigated according to Carrel-Dakin technic. The condition then showed slight improvement. Cultures from the wound showed a mixed culture of pneumococcus type II and staphylococcus aureus.

Improvement was such that the patient was up and about from June 18 to June 25. He was then returned to bed because of accumulation of fluid in the left chest as shown by physical signs and röntgenogram.

Operation for open drainage of the left pleural cavity was performed fifty-one days after the first operation (July 3). The technic was the same as for the first operation, except that the ninth instead of the eighth rib was resected. Culture from this side showed a pure growth of pneumococcus which was not typed. Rapid improvement followed this operation and the temperature remained within normal limits after the fifth day post-operative.

The patient was discharged in excellent condition July 13. He left against advice, but the right wound had completely healed, and the left was closed and granulating.

A follow-up a year later, July 25, 1919, showed the patient in good health.

CASE III.—A boy of two and three-quarter years was admitted to The New York Hospital September 19, 1917. The *family history* and *previous history* were irrelevant. *Present illness*.—The child was taken with cough and fever September 1. He grew worse and developed severe dyspnoea on September 12. *Physical examination* on admission revealed a very sick white boy coughing frequently. The left lung showed dullness, bronchial breathing, and a few coarse râles below the angle of the scapula posteriorly, and dullness between the third and sixth ribs anteriorly. The right lung was normal. The heart was displaced, slightly, to the right. The leucocytes were 38,600 per cubic millimetre of blood; 86 per cent. were polymorphonuclear leucocytes. The urine was normal, and the examination otherwise normal.

A provisional *diagnosis* of lobar pneumonia, left, and empyema (?) was made. Suspicious signs of empyema were reported by röntgenogram taken the next day.

The patient's condition became progressively worse. Nine days after admission (September 28) a left thoracentesis was done and yielded about 5 cubic centimetres of thick pus. Culture of the pus returned a pneumococcus.

The operation of open drainage of the left pleural cavity was performed eight days after thoracentesis (October 6). Without anaesthesia an intercostal incision was made in the eighth left interspace and scissors were forced through the pleura into a large empyema cavity, from which much thick pus ran out. Two drains were placed in the cavity.

The post-operative condition was better for about a week, but was progressively worse thereafter. A röntgenogram taken October 14 showed no signs of fluid, however.

November 11 fluid was discovered in the right chest. Marked emaciation was also present. The next day, thirty-five days after the first operation, an operation was performed for open drainage of the right chest using the same technic as on the left. Pus was obtained; it was sterile.

Following operation there was no improvement, and the child died eight days after the second operation (November 20).

BILATERAL PLEURAL EMPYEMA

CASE REPORTS OF BILATERAL EMPYEMA, 1910 TO 1930

1 Author and year	2 3 Patient		4 Days from diagnosis of empyema until first operation	5 Primary disease	6 Organism cultured from empyema	7 Type of drainage	8 Days be- tween opera- tions	9 Re- sult
	Age	Sex						
1. Edmond 1910 ²³	5			Pertussis; broncho-pneu- monia	?	1—Right, open 2—Left, open	7	C
2. Corner and Grant 1911 ²⁴	29	F	0	?	?	1—Right, open; re- section of rib 2—Left, open; re- section of rib	1	C
3. Gand and Poissonier 1911 ²⁵	4	M		"Grippe"; pneu- monia	?	Open, simultaneous	0	C
4. Bozzotti 1913 ²	25	F	11	?	?	1—Left, open; rib resection 2—Right, open; rib resection	5	C
5. Zingher 1913 ²⁶	6.5	M	0	Bilateral bronchopneu- monia	Pneumo- coccus	1—Left, open; re- section 8th rib 2—Right, open; in- tercostal incision and drainage	26	C
6. Mackenzie 1914 ⁸ and 1924 ²⁷ 7.	34	M		"Influenza"	?	Open, simultaneous	0	C
	?	M		"Influenza"	?	1—Right, open 2—Left, open	1	C
8.	?	M		"Influenza"	?	1—Right, open 2—Left, open	1	C
9.	7		0	?	?	Open, simultaneous	0	C
10. Bunts 1914 ²⁸	13	?	?	Acute appendi- citis, operation; pleural pneu- monia	?	1—? open 2—? open	?	C
11. Lund and Morrison 1916 ²⁹	16	F	7	Left lower lobar pneumonia; right middle and lower lobar pneumonia	?	1—Left, open; 9th rib resected 2—Right, open	1	C
12. Cafritz 1918 ¹⁶	?	F	?	"Grippe"	?	1—Left, open; 8th rib resection 2—Right, open	23	C
13. Norrlin 1919 ³⁰	8	F	11	Pneumonia	Diplococcus pneumo- coccus?	1—Right, open; 8th intercostal incision 2—Left, open; same technic	28	C
14. Gundrum 1920 ³¹	26	M	22	Left lower lobar pneumonia; right lower lobar	Pneumococ- cus type IV	1—Right, closed; #18 F. catheter in 10th right inter- space 2—Left, closed; same technic	25	C
15. Durham 1920 ³²	14	M	8	Influenza; otitis media; bilat. mastoiditis; bilat. parotitis; pneumonia	Staphylococ- cus aureus	1—Left, open; 9th rib resected; re- peated aspirations 2—Right, open; 8th rib resected	42	C

E. LAWRENCE KEYES

CASE REPORTS (Continued)

1 Author and year	2 3 Patient		4 Days from diagnosis of empyema until first operation	5 Primary disease	6 Organism cultured from empyema	7 Type of drainage	8 Days be- tween opera- tions	9 Re- sult
	Age	Sex						
16. Glenn 1920 ³⁵	Child	?	?	Left empyema fol- lowed by right	?	?	?	D
17.	Child	?	?	Left empyema fol- lowed by right	?	?	?	D
18. Jehn 1921 ³⁴	24	F	14	Pneumonia, left	?	1—Left, closed; rib resection 2—Right, closed; rib resection	11	D *
19.	50	F	?	Bilateral encap- sulated empy- ema	?	Both sides drained; methods not stated	?	C
20. Ladd and Cutler 1921 ³⁵	Child	?	?	?	?	Simultaneous bilat- eral open drainage	0	C
21.	Child	?	?	?	?	Simultaneous bilat- eral open drainage	0	C
22.	Child	?	?	?	?	?	?	D
23. Stenius 1920 ³⁶	?	?	?	?	?	?	25	C
24. Schweizer 1921 ³⁷	51	?	?	A chronic empy- ema, probably of tuberculous origin	?	?	?	D
25. Beck 1921 ¹⁷	36	F	?	Influenza; bilat- eral broncho- pneumonia; pregnancy, 8th month	?	1—Right, closed in- tercostal, followed 21 days later by resection of 8th rib 2—Left, closed	24	C
26. Andrenelli 1923 ³⁸	43	M	?	Abdominal symp- toms; retention of urine	? Exudate was serofibrinous	No operation; re- peated aspirations	?	C
27. Auer 1925 ³⁹	8	F	2 (?)	Acute respiratory infection; pneumonia	Pneumococ- cus	1—Right, open (?) with rib resection; repeated aspira- tions 2—Left, closed	16	C
28. Hedblom 1925 ⁴⁰	19 mos.	M	?	Bronchopneu- monia	?	1—Right, closed (?) with rib resection 2—Left, closed (?) with intercostal drainage	?	C
29. Mackey 1925 ⁴¹	29	M	1 (?)	Lobar pneumo- nia rt. lung and left lower lobe	Pneumococ- cus and pneumo- bacillus	1—Left, closed; costal drainage 2—Right, closed; in- tercostal drainage	22	C
30. Matthews 1927 ⁴²	5	M	?	Pneumonia, left (lobar)	Streptococ- cus viridans	1—Left, closed (in- tercostal drainage) 2—Right, closed (intercostal drain- age)	17	C

BILATERAL PLEURAL EMPYEMA

CASE REPORTS (Continued)

1 Author and year	3 Patient		4 Days from diagnosis of empyema until first operation	5 Primary disease	6 Organism cultured from empyema	7 Type of drainage	8 Days be- tween opera- tions	9 Re- sult
	2 Age	Sex						
31. Graves 1928 ⁴³	6	F	4	Acute appendicitis; appendectomy; (tertian malaria); lobar pneumonia, right upper	Pneumococcus	1—Right, open, with rib resection 2—Left, open, with rib resection	5	C
32. Scanlan 1928 ¹	21	F	11	Lobar pneumonia, both lower lobes	B. Coli	1—Left, closed (intercostal drainage) 2—Right, closed (intercostal drainage)	3	C
33. Tixier and de Sèze 1929 ⁴⁴	8	M	2	Lobar pneumonia, left Lobar pneumonia, right	Pneumococcus	1—Left, open, with rib resection 2—Right, closed	63	C
34. Ravnitzky and Bogin 1930 ⁴⁵	5	F	?	Pneumonia	?	1—Right, intercostal 2—Left, rib resection	33	C
35.	17 mo.	F	?	Pneumonia, both sides	?	No operation; repeated aspirations; brain abscess		D
36.	2½	M	5	Otitis media; acute lobar pneumonia, both bases and right middle	Pneumococcus	1—Left, intercostal drainage 2—Right, rib resection	37	C
37.	8	F		Bronchopneumonia	Pneumococcus	1—Right, rib resection 2—Left, rib resection	26	C
38.	1	F		Pneumonia (lobar) left upper and right base	Streptococcus	Left, chest tapped; no operation		D
39. Keyes Case 2 above	17	M	?	Bronchopneumonia	Pneumococcus, type II (Right side also showed streptococcus viridans and staphylococcus aureus)	1—Right, open, with rib resection 2—Left, open, with rib resection	45	C
40. Case 3 above	2¾	M	?	Lobar pneumonia, left	Pneumococcus	1—Left, open; intercostal drainage 2—Right, open; intercostal drainage	37	D
41. Case 4 above	2	F	6	Bronchopneumonia	Pneumococcus, type I	1—Right, closed; intercostal drainage 2—Left, closed; intercostal drainage	12	C

* Death from intercurrent infection. Autopsy showed caseous tuberculosis of left side.

E. LAWRENCE KEYES

SUMMARY AND CONCLUSIONS

1. Forty-one cases of bilateral empyema occurring from 1910 to 1930, three previously unreported, are summarized.
2. The natural history and treatment of the disease are outlined.
3. The literature since the last complete reports is reviewed.
4. Attention is called to simultaneous bilateral thoracotomies as an advisable method of treatment under certain circumstances.
5. It is recommended that the second side be drained very soon after the first.
6. The initial drainage should be of the closed type.

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SUBCUTANEOUS RUPTURE OF THE SPLEEN*

TWO CASES WITH BLOOD COUNTS FOLLOWING SPLENECTOMY†

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THESE cases are reported particularly because of their normal blood counts following splenectomy. Without going into individual case reports, the impressions obtained by reading the literature listed at the end of this article might be briefly stated as follows (considering only those cases from which a ruptured normal spleen had been removed):

In the early days of splenectomy when clamps were left on the pedicle, large packs were placed down to the pedicle, or large drains were inserted as routine procedure, a persistently high total and polymorphonuclear count was invariably noted. If the time when the wound became clean was noted, this time checked with the time at which the leucocyte count became normal. A severe secondary type of anæmia was always reported which required months to return to normal. This is readily explained by the original hæmorrhage followed by the depletion from the large infected draining wound.

In more recent literature the severity of these two conditions is given less emphasis. Instead there is reported usually an immediate polymorphonuclear leucocytosis, often a lymphocytosis, and in many cases a transient anæmia of the secondary type. Several men report an increasing eosinophilia following removal of the spleen. Others report a moderate anæmia lasting for years.

CASE I.—J. McM., aged fifteen years, was admitted to Knickerbocker Hospital, February 1, 1928. One hour before admission, while coasting down a hill, he had struck an electric light pole. Immediately, he noticed a severe pain in the upper abdomen associated with nausea and vomiting. This was followed within a few minutes by a feeling of faintness.

Examination was that of a white boy in extreme shock. His pulse was 140, temperature 97°, and respirations 30. No external evidence of injury could be found except a small contusion on the left lateral chest wall two inches above the costal margin. The chest findings were otherwise normal but for rapid shallow respirations with less excursion of the diaphragm on the left than on the right. The abdomen was generally rigid, with the rigidity most marked in the upper left quadrant. The right flank was tympanitic; the left was dull. This dullness extended upward to a greatly increased area of splenic dullness.

The urine was normal but for an occasional red blood cell. The admission blood count was: Red blood cells 3,770,000 hæmoglobin 65, white blood cells 23,400, polymorphonuclear leucocytes 84, and lymphocytes 16.

* Presented before the Surgical Section of the New York Academy of Medicine, May 2, 1930.

† Blood counts to December 6, 1930.

SUBCUTANEOUS RUPTURE OF THE SPLEEN

Operation was done immediately with a pre-operative diagnosis of ruptured spleen.

Under ether anaesthesia, the abdomen was opened through an upper left rectus incision. Fresh fluid blood showed as soon as the peritonæum was incised. One-half of the spleen was found in the lower right quadrant near the cæcum, still attached to the pedicle by a long narrow strip of peritonæum. This attachment did not contain any blood-vessels large enough to be seen. The other half of the spleen was in its normal location.

There was a tear about three inches long in the lesser omentum and another in the peritonæum of the lateral abdominal wall, beneath which was a small hæmatoma. The kidney was not examined. No damage to the tail of the pancreas was apparent. Two small accessory spleens were noted attached to the pedicle of the spleen and were left undisturbed. They were each about the size and shape of a navy bean.

The pedicle was long enough to be clamped and cut. It was then transfixed and ligated twice. The pedicle and the two tears in the peritonæum were peritonized. The abdomen was closed in layers without drainage. Immediately following the operation 800 cubic centimetres of whole blood were transfused by the Soresi method.

Convalescence was uneventful except that, on the fourth day, by some mistake, the skin and tension sutures were all removed by one of the internes. The wound opened up to the fascia. It was closed with strips of adhesive and healing occurred without further complication. A very firm scar resulted.

This patient has been followed at regular intervals since. His health and growth have been normal. Aside from an occasional slight cold he has had no illnesses. The blood counts are shown on the accompanying chart.

CASE I

	Hgb.	Red b.c.	Leucocytes	Polys.	Lymph.	Misc.
Pre-op.						
Half-hour	65	3,770,000	23,400	84	16	
	(800 cc. whole blood Soresi method immediately post-op.)					
Post-op.						
1st day	88	4,400,000	11,200	80	20	
18th day	88	4,400,000	12,800	78	22	
6 mos.	95	4,800,000	9,200	75	25	
15 mos.	100	5,100,000	8,600	70	30	
24 mos.	100	6,400,000	10,600	72	28	
27 mos.	106	5,590,000	9,700	56	41	E. 3
32 mos.	100	5,700,000	9,600	60	39	E. 1
34 mos.	104	5,500,000	7,800	54	44	E. 2

CASE II.—M. L., aged eight years, was admitted to St. Luke's Hospital at 5:15 P.M., December 7, 1929. Two hours before admission, while he was trying to help move a large touring car, the car suddenly backed and the rear wheel passed over his abdomen. He was brought into the hospital because of the increasing pain in the upper abdomen. Immediately after admission about a pint of fairly fresh blood was vomited.

Examination was that of an acutely ill white boy, suffering severe pain in the upper abdomen. He was quite pale. His pulse was 116, temperature 98.4°, and respirations 20. The only external evidence of injury was a bruised area over the right anterior superior iliac spine about which was an ecchymosis, measuring approximately 1 by 2 inches.

The chest was normal but for limited excursion of the diaphragm. The abdomen was generally tender to pressure, with rigidity of both recti above the umbilicus. This was most marked on the right side. No masses could be palpated. Both flanks were tympanitic. There was a questionable increase in the liver dulness in the mid-line.

HAROLD J. SHELLEY

As the patient did not think that he had voided since the accident and was unable to do so, he was catheterized. Two ounces of normal urine were obtained. The admission blood count was: Red blood cells 3,850,000, hæmoglobin 76, white blood cells 24,300, polymorphonuclear leucocytes 84, and lymphocytes 16.

At 6:10 P.M. patient again vomited a considerable quantity of fairly fresh blood.

At 6:35 P.M. he was much worse. His physical findings were unchanged except that the tenderness and rigidity in the right upper abdomen had increased. Operation was then done immediately. The pre-operative diagnosis was retroperitoneal rupture of the duodenum because of the location of the increasing tenderness and rigidity, and the vomiting of blood without any obliteration of the liver dulness. The absence of dulness in the left flank apparently excluded rupture of the spleen unless it had occurred with very little hæmorrhage.

Field block and local infiltration with novocain was used. The abdomen was opened through the upper right rectus muscle. There was fresh blood beneath the peritonæum, but no gas. The liver surfaces were smooth. Anteriorly the stomach and transverse colon were normal. No blood came from the lesser omental sac. A large amount of fresh blood and clots were found high up under the left costal arch and in this the spleen was felt divided into two separate portions. The tail of the pancreas was not visibly injured.

The incision was extended upward. Traction on the abdominal wall made the patient very uncomfortable, so that he was given ether for the remainder of the operation. By retracting the left side of the incision, the pedicle of the spleen could be exposed quite readily. It was transfixed and ligated doubly. The spleen was then cut away and the stump peritonized. A small rent in the lesser omentum was closed and the edges covered with peritonæum.

No further exploration was done. The abdomen was closed in layers without drainage. An infusion of 500 cubic centimetres of normal saline was given during the operation. A transfusion of 750 cubic centimetres of whole blood was given by the Lindeman method before the patient left the operating table.

Because of the possibility of an undiscovered retroperitoneal injury to the stomach or duodenum, nothing was given by mouth for the first four days. During this time

CASE II

	Hgb.	Red b.c.	Leucocytes	Polys.	Lymph.	Platelets	Misc.
Pre-op.							
1 hour	76	3,850,000	24,300	84	16		
			(750 cc. whole blood Lindeman method immediately post-op.)				
Post-op.							
1st day	83	4,500,000	13,300	78	22		
2nd day	93	4,600,000	10,500	86	14		
3rd day	86	4,500,000	9,000	82	18		
4th day	93	4,550,000	9,900	82	17		E. 1
5th day	88	4,250,000	15,000	82	20		
6th day	88	4,300,000	14,000	78	22		
8th day	84	4,300,000	9,200	75	25		
19th day	98	4,900,000	7,200	43	55	350,000	E. 2 *
1½ mos.	90	4,950,000	6,950	50	47		E. 3
3½ mos.	88	4,800,000	8,000	64	36	270,000	
4½ mos.	83	4,500,000	8,000	72	26	165,000	Mon. 2
10 mos.	83	3,750,000	5,200	54	44	180,000	E. 2
12 mos.	70	4,500,000	11,000	65	34	230,000	E. 1

* Reticulated red blood cells 2 per cent. Few young polymorphonuclear leucocytes.

SUBCUTANEOUS RUPTURE OF THE SPLEEN

normal salt and 5 per cent. glucose solutions were given by hypodermoclysis every eight hours. He was then put on the regular gastric post-operative routine. (Gastro-intestinal röntgenograms made three months later showed no pathology.)

Convalescence was uneventful. His health and growth have been normal since the operation. He has had no illnesses. His indoor life in the city probably accounts for the moderate secondary anæmia in the last two counts.

SUMMARY

Two cases of subcutaneous rupture of the spleen are reported which were treated by splenectomy without drainage. In both, the large whole blood transfusion evidently replaced the blood lost by hæmorrhages. These resulting red counts were maintained. The leucocyte count and differential do not appear to be other than would be expected following any similarly large operation. However, in both cases eosinophiles do appear in the later counts but not to an abnormal percentage.

The possibility of a difference between the two cases is suggested by the last counts. Case I has maintained this high count. He had two small accessory spleens. In Case II the last two counts show a moderate secondary anæmia. No accessory spleens were noted in this case. Additional counts in the future on these two patients may prove very interesting for this reason.

DISCUSSION.—DR. ELSWORTH ELIOT, JR., remarked that in 1907 two cases of splenectomy for subcutaneous rupture of the spleen were reported by him to the American Surgical Association. At that time the number of cases in surgical literature were few in number and, in the still fewer instances of recovery, were without mention of any ultimate change in the composition of the blood as well as in the general condition of the patient. In the paper referred to, examination of the blood of both patients a year after operation showed little change from the normal. Whether or not the loss of the spleen was followed by any constitutional disturbance, including diminished resistance to infections, was also discussed, showing that usually any impairment was transitory and that eventually patients returned to a normal condition. This is to be accounted for by the gradual compensatory increase in adenoid or lymphoid tissue and in the bone marrow, as well as in the enlargement of small frequently unobserved accessory spleens occasionally present in the gastro-hepatic omentum. Such accessory spleens, no larger than a small finger-tip, were later observed in a boy of ten in whom a splenectomy was performed for rupture, in whom examination of the blood one year later proved quite normal. That this favorable outcome does not always obtain was recently observed in the case of a previously strong young man who, one year after splenectomy for rupture, showed a marked tachycardia with a hæmic murmur. As an electrocardiogram proved normal, the ultimate prognosis in this instance is probably favorable.

He called attention to the second case reported by Doctor Shelley because of the more pronounced evidence of peritoneal irritation on the right side. Ordinarily the tenderness in the left flank, increased by pressure on unbroken eleventh and twelfth ribs, the dulness or flatness, especially on auscultation in the left ilio-costal space and the rigidity of the left rectus, especially in its upper portion, have proved the most reliable physical signs. Of unusual occurrence is to be mentioned the upward displacement of the apex beat of the heart. This was noted in one case seen by him in which the accumulated blood in the peritoneal cavity was relatively small in amount.

HAROLD J. SHELLEY

As to treatment, all agree that splenectomy at the earliest possible moment is the operation of choice. That in certain cases the spleen may be conserved is quite true. Thus in a young girl of twelve who had merely slipped off her pony on to soft turf, the symptoms were so slow and insidious that the abdomen was not explored until the third day after the accident. At that time bleeding had ceased and, after the clotted blood was removed, a tampon of gauze was introduced to forestall the possibility of a renewal of the hæmorrhage, with a successful result. In cases, however, where indications of alarming hæmorrhage develop rapidly, splenectomy must be regarded as the only procedure.

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INTRA-ABDOMINAL APOPLEXY

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FROM THE SURGICAL CLINIC OF THE PETER BENT BRIGHAM HOSPITAL

SPONTANEOUS rupture of arteriosclerotic vessels within the abdomen is extremely rare. A patient recently operated on by us presented this unusual and striking pathological picture, *i.e.*, rupture of a major branch of the left gastric artery with a dissecting hæmatoma of the gastro-hepatic omentum and a large amount of blood in the peritoneal cavity. A search through the literature has disclosed only two similar cases of hæmoperitonæum actually demonstrated at the operating table, one case which was comparable save for the fact that the ruptured vessel was not located, and one case in which operation was not performed.

Gross aneurisms of visceral arteries are found with comparative frequency and occasionally rupture. Spontaneous rupture of vessels of the extremities² has been reported and Lincoln⁶ has recorded rupture of the renal artery retroperitoneally. Traumatic rupture of abdominal vessels likewise occurs not infrequently.⁷ None of these conditions, however, may be classified as true intra-abdominal apoplexy.

REPORT OF CASES

CASE I.—*Authors'*—M. M. K., Surg. No. 35362. A widow, fifty-four years of age, entered the hospital complaining of severe abdominal pain of five hours' duration.

Past History.—The patient sustained an intra-ocular hæmorrhage five years previously. Three years later she sought medical advice because of loss of weight and epistaxis. During the past year she had had occasional attacks of sudden, sharp pain in the precordium, radiating to the left shoulder and gradually increasing in frequency. Six months prior to admission she was told by her local doctor that her systolic blood-pressure was 270. Rest was advised but was not carried out. A gradual loss of forty pounds in weight had occurred during the past two years. There was no history of epigastric distress; there were no bloody, tarry, or clay-colored stools. Her appetite was good and her bowels were regular with saline catharsis.

Present Illness.—While preparing her supper, five hours previous to admission, the patient was seized with a sudden attack of very sharp pain in the mid-epigastrium, rapidly spreading over the entire abdomen. The pain was prostrating in character, constant and agonizing. Nausea developed and she vomited a small amount of clear fluid.

Physical Examination.—A well-developed but poorly nourished, elderly white woman lying in bed with her knees drawn up, obviously in pain. The skin was dry, somewhat wrinkled, but not unduly warm. The heart was enlarged to the left and a rough systolic murmur was audible at the apex. The aortic and pulmonic sounds were of about equal intensity. The peripheral vessels were sclerotic. The systolic blood-pressure was 170, the diastolic was 110. Palpation of the abdomen revealed a board-like rigidity throughout with diffuse tenderness of marked degree, most intense in the epigastrium. No fluid could be demonstrated in the peritoneal cavity. Hepatic dulness was normal. Vaginal and rectal examination disclosed tenderness in both lateral pelvic vaults.

INTRA-ABDOMINAL APOPLEXY

Clinical Pathology.—On admission the temperature was 99.4 degrees by rectum, the pulse rate was 100, and the respiratory rate, 20. The leucocyte count was 16,000 and 20,000 at two examinations. The urine showed a large trace of albumen and a slight trace of sugar. The sediment contained numerous hyaline casts, occasional leucocytes and red blood cells.

Pre-operative diagnosis was cardiorenal-vascular disease and either perforated peptic ulcer, acute pancreatitis, or perforated carcinoma of the stomach.

Operation.—Ligation of branch of left gastric artery, partial evacuation of hæmatoma of gastro-hepatic omentum, removal of blood from the peritoneal cavity; novocain and ether anaesthesia.

After a preliminary dose of morphia and scopolamin, the abdominal wall was infiltrated with novocain and opened through an upper right rectus incision. Bloody fluid escaped immediately after incising the peritoneum. Light anaesthesia with ether was then

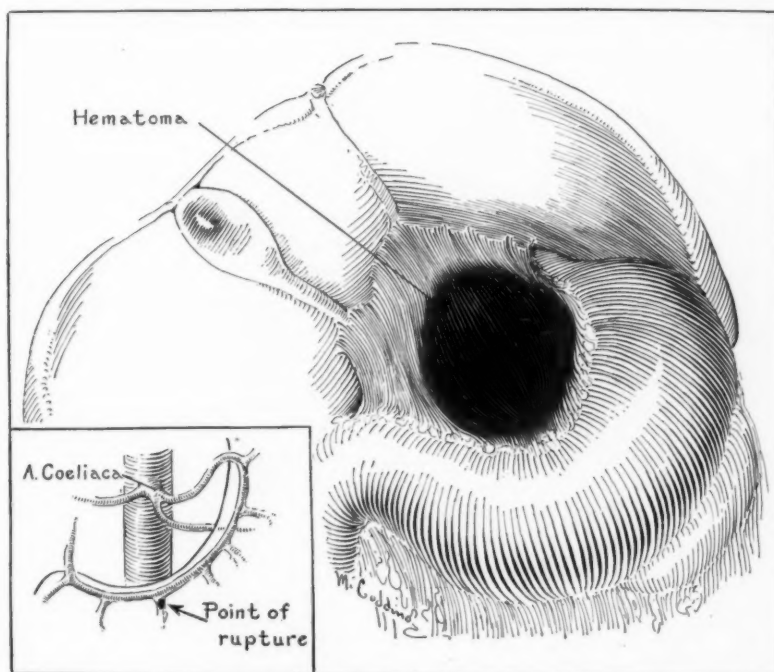


FIG. 1.—Hæmatoma of the gastro-hepatic omentum. Insert shows the point of rupture in a primary branch of the left gastric artery.

induced and a careful exploration was carried out. A large hæmatoma was found in the gastro-hepatic omentum, extending from the mid-portion of the lesser curvature of the stomach upward to the cardia and outward for approximately 3 inches (Fig. 1). The anterior leaf of the omentum was incised near the lesser curvature, the hæmatoma was partially evacuated, and a sclerotic branch of the left gastric artery was found to be ruptured and bleeding smartly. Ligatures were placed around the vessel on each side of the bleeding point and the hæmorrhage ceased. The abdomen was closed with drainage. At the end of the operation the systolic blood-pressure was 180, the diastolic, 100. The patient's general condition was good.

Post-operative Course.—Five hours later the systolic blood-pressure was 260, the diastolic, 135. There was no post-operative vomiting and no abdominal distension. Drainage from the wound was slight. An intravenous phthalein test on the sixth day showed a renal function of 40 per cent. The convalescence was unremarkable. The patient's

general condition improved, the blood-pressure gradually subsided, and she was discharged on the thirty-third post-operative day. The wound was firmly healed; the temperature, pulse rate and respiratory rate were normal; the leucocyte count was 9,300; the systolic blood-pressure was 160 and the diastolic, 95.

Subsequent Note.—The patient was seen eight months later. During this interval she had been well except for occasional headaches. Her blood-pressure was, systolic, 260, diastolic, 145. Abdominal examination was entirely negative. The wound was well healed.

CASE II.—*Starcke*.⁸—A man, sixty years of age, entered the hospital because of severe epigastric pain. The past history included gastro-intestinal symptoms for many years, characterized by eructations of gas, nausea, constipation and occasional diarrhoea. Dyspnoea and palpitation had been prominent during the two years prior to admission.

Physical examination disclosed an elderly man in severe pain. The skin was cold and clammy. The heart was enlarged; a systolic murmur, maximal at the apex, and many extra systoles were audible. The radial arteries were palpably sclerotic. The abdomen was rigid and tenderness was marked, particularly in the epigastrium. Deep palpation was impossible. There was no discernible dullness in the flanks. The temperature was 99.4 degrees.

Operation was performed immediately. The omental bursa was filled with blood which was escaping into the general peritoneal cavity through the foramen of Winslow. A rupture of the gastro-duodenal artery was found to be the cause of the hæmorrhage. The bleeding point was grasped and ligated.

The post-operative course was uncomplicated and two months later the patient was in relatively good health. The systolic blood-pressure was 155.

CASE III.—*Budde*.⁹—A man, twenty-seven years of age, previously well, suddenly developed severe pain in the left hypochondrium. When admitted to the hospital several hours later tenderness and spasm of the abdominal wall were generalized but most marked in the left upper quadrant. A tentative diagnosis of perforation of the stomach or acute pancreatitis was made.

Abdominal exploration revealed liquid blood throughout the peritoneal cavity and large clots in the left hypochondrium. Further investigation disclosed a rupture in one of the branches of the left gastro-epiploic artery. A huge hæmatoma of the omentum was found in this region. The bleeding point was ligated and recovery was complete. The patient was in good health six months later.

CASE IV.—*Hilliard*.⁶—A man, aged forty-eight years, was seized with severe epigastric pain one hour before admission to the hospital. During the previous eight years he had had attacks of dizziness, and headaches associated with marked arteriosclerosis and some loss of power in the lower extremities. During this period, the systolic blood-pressure had varied between 160 and 190. Three years prior to admission he sustained a left hemiplegia from which he had largely recovered.

When admitted the patient was in very severe pain. The abdomen was distended, rigid, and board-like. There was dullness in both flanks; percussion of the liver was normal. The pulse rate was 80; the temperature was subnormal.

Abdominal exploration was performed. The peritoneal cavity was filled with blood. "Hæmorrhagic patches were scattered over the mesocolon." There was no evidence of fat necrosis. No bleeding vessel was found and the abdomen was closed. The patient died six hours later.

CASE V.—*Ducuing and Florence*.⁴—A young woman, eight months' pregnant and seriously ill, was admitted to the hospital because of generalized abdominal pain associated with complete obstipation of forty-eight hours' duration. The respiratory rate was 50, the pulse rate, 90. Considerable flatus and a small amount of fæcal material were obtained after the administration of an enema. The patient was in labor at entry and parturition was completed four hours later.

INTRA-ABDOMINAL APOPLEXY

Her condition did not improve. The abdominal wall was spastic and signs of free fluid were noted. A puncture was made in the pouch of Douglas and blood was obtained. Operation was not performed. The patient died.

Post-mortem examination disclosed blood throughout the general peritoneal cavity. A rupture was found in one of the branches of the superior mesenteric artery with early gangrene of the bowel along the distribution of this vessel.

No statement was made concerning the condition of the vascular system.

Comment.—The case reported by Starcke was entirely comparable to our own except for the site of hæmorrhage. The case of Budde was likewise similar although the author did not record the patient's blood-pressure nor comment on the presence of evident arterial disease. Hilliard's case was comparable in symptoms and operative findings although the actual bleeding vessel was not found. Post-mortem examination was not made and consequently definite proof that the case should be included in this group is absent. The case of Ducuing and Florence was not reported in detail. The accident occurred during labor and the ruptured vessel was found only at autopsy. No comment was made concerning the condition of the vascular system. Whether or not the case should be included in this series or classified as a traumatic complication of labor is uncertain.

It seems unusual that intra-abdominal apoplexy does not occur more frequently. Allbutt¹ has pointed out that the cerebral and visceral arteries are similarly affected in the type of arteriosclerosis which occurs in "essential hypertension." In these cases, next to cardiac complications, cerebral apoplexy is the most common cause of death, yet an abdominal lesion of this type is almost unknown. The relatively frequent incidence of cerebral lesions may depend in part on the variance in anatomical structure of the vessels in the two areas, and in part on the fact that a minute hæmorrhage in the cranial cavity is productive of symptoms out of all proportion to the actual lesion. A similar process within the abdominal cavity may remain entirely unrecognized.

In reviewing these cases certain salient features may be emphasized.

1. Three of the patients presented both historical and clinical evidence of vascular disease. They were hypertensive and showed a marked degree of arteriosclerosis. In the remaining two cases the authors made no comment concerning the condition of the vascular system.

2. The outstanding symptom in each case was sudden and severe abdominal pain, prostrating in character and most intense above the level of the umbilicus. The mechanism of this symptom must depend partly on the irritation of the peritonæum by blood and, in two cases at least, on the distension of the omentum by a dissecting hæmatoma.

3. Physical findings were uniformly marked by a state of partial shock and by the presence of an extremely tender and rigid abdomen.

4. A presumptive diagnosis of perforated peptic ulcer, or acute pancreatitis was made in all cases and, in retrospect, there seems to be no method of differentiation. The evidence of marked vascular disease and the absence

of previous gastro-intestinal symptoms offer the only clue to the true nature of the disease.

Summary.—A case of spontaneous rupture of a primary branch of the left gastric artery has been recorded. Only four comparable cases have been found in the literature. These patients presented symptoms and physical findings which suggested a pre-operative diagnosis of perforated peptic ulcer or acute pancreatitis. Abdominal exploration in four cases revealed a large hæmoperitonæum. The fifth was demonstrated at autopsy. In three instances the bleeding vessel was identified and ligated and the patients recovered. These cases have been classified under the general term of intra-abdominal apoplexy.

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SUBPHRENIC ABSCESS*

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SUBPHRENIC abscess, while not rare, is one of the less frequently encountered complications of peritonitis although, as is well known, it may arise secondarily to causes other than infection within the peritoneal cavity.

At the Pennsylvania Hospital from 1910 to 1926, ten cases were recorded and in an additional one, although the clinical and X-ray findings suggested that an abscess was present, in view of the fact that exploration was not done, the case is not included in the present series. No case of subphrenic abscess has been seen in this institution since 1926. At the Presbyterian Hospital, from 1922 to 1931 there were eight cases—a total of eighteen, and for the privilege of reporting these two groups I am indebted to the surgeons upon whose services they were admitted.

We fully realize that this is a very small series and that in presenting it we have nothing new to add, but thought that from the clinical aspect some of the cases might present features of interest and serve to promote a discussion among the members of this society.

As is well known, the majority of cases of subphrenic abscess arise secondary to a perforation of an abdominal viscus—stomach, duodenum, appendix or gall-bladder—but one must bear in mind that it may also result from an abscess of the spleen, liver, kidney, pancreas or spine; from traumatism, pyæmia and distant foci of infection, such as carbuncle, etc. In the group we are recording only seven cases actually followed a perforation of an abdominal viscus. It may also follow infection above the diaphragm; such as pneumonia, empyema, lung abscess, osteomyelitis of ribs, etc. In those cases in which the subphrenic abscess apparently follows an empyema thoracis, one must bear in mind the possibility of its having been caused by perforation of the diaphragm by the exploring needle, and of subsequent infection of the subphrenic region. When the stomach—exclusive of the pyloric region—the pancreas or the spleen is the primary focus, the subphrenic abscess is usually on the left side, most of the other sources giving rise to an abscess on the right.

It is not our intention to describe again in detail the anatomy of the subphrenic areas as nearly all of the recorded series of this type of abscess are accompanied by such a description with references to the excellent article by Barnard.¹ Those interested in this aspect of the subject are referred to the above paper and to one by Lockwood² of The Mayo Clinic. Sufficient to state that for practical purposes the subphrenic area may be

* Read before the Philadelphia Academy of Surgery, January 5, 1931.

divided into right and left anterior and posterior intraperitoneal; and right and left extraperitoneal spaces.

The diagnosis of subphrenic abscess often presents many features of interest, not the least difficult of which is the determination of whether the collection of pus lies above or below the diaphragm, or both; or whether the condition present is an abscess within the liver. In our experience the associated findings in the chest, such as secondary compression of the lung and changes in the breath sounds, tactile and vocal fremitus, "splashing" sounds on moving the patient, etc., are often quite confusing and may at times be misleading.

From the viewpoint of surgical diagnosis our chief reliance is based on the history of a preceding infection; more or less localized tenderness with possible fullness and induration over the involved area; evidence of pus somewhere in the body as shown by temperature range, leucocytosis, toxic condition of the patient, etc.; X-ray examination, and exploratory puncture. As has been emphasized by numerous writers, one of the chief reasons for not recognizing the condition is failure to consider the possibility of its existence.

Occasionally one encounters a case of subphrenic abscess in which there is no antecedent history of demonstrable infection, as was seen in the case of a man of twenty-seven years who entered the hospital complaining of swelling in his right chest wall. Five weeks before admission he noticed a small, painless, slightly reddened swelling over the anterior part of his right chest. His previous medical history was irrelevant and physical examination was essentially negative aside from the above-mentioned swelling which was about 15 by 20 centimetres in diameter, extending over the seventh, eighth and ninth ribs on the antero-lateral aspect of his chest. A subphrenic abscess was not suspected and unfortunately an X-ray of his chest was not taken. The pre-operative diagnosis was suppurative perichondritis.

Under local anæsthesia the abscess was incised with the escape of "an abundant amount of pus," which gave a positive culture for *B. coli communis*. Digital exploration revealed that the abscess had perforated through the eighth interspace and resection of the eighth rib uncovered an extensive subphrenic abscess cavity. Drainage was instituted and recovery was uneventful, he being discharged from the hospital on the twenty-fifth post-operative day.

In this instance it might be suggested that involvement of the rib was the primary focus but there was no history of previous injury, unrecognized typhoid or any other infection which would imply that the process started from the rib.

The question of sex is, we believe, incidental, thirteen males and five females, and aside from the fact that the condition is less apt to occur in children—four in the series being under ten years of age—age is apparently not of much importance. Its greater frequency in men is probably because perforation of an abdominal viscus is more frequently encountered in men than in women, and more so in adults than in children.

As was to be expected, most of the cases followed a previous operation. Thus five had had appendectomies which required drainage; two resulted

SUBPHRENIC ABSCESS

from perforation of a peptic ulcer. (During the period covered by this report there were one hundred and thirteen cases of perforated peptic ulcer operated upon in the Pennsylvania and Presbyterian Hospitals.) Two followed cholecystostomies; one arose subsequent to a cæcostomy; one as a sequence to puerperal fever with secondary abscess of the spleen; one followed an abdominal exploration in which no pathological condition could be demonstrated, the subphrenic abscess apparently being overlooked at the time, and in six instances there had not been any previous operation.

From the above figures it will be seen that eight of the eighteen cases occurred without evidence of demonstrable previous peritoneal infection. As an example of this latter group may be cited the case of H. B., an infant of twenty-two months, who was admitted to the hospital suffering with a "cold" following measles. The condition began as a "cold" of two weeks' duration, six weeks before admission. Measles, lasting two weeks, developed, and at the end of this period evidence of pneumonia was present. On examination of the chest dulness was detected at the right base both anteriorly and posteriorly; the heart was not displaced and the abdomen was somewhat distended. The temperature, pulse and respiration were 102°, 144 and 40 respectively. An X-ray of the chest made on the day of admission showed that the right and left sides of the diaphragm presented nothing abnormal, and the size and position of the heart were normal. Blotching of the lungs was attributed to recent pneumonia. The medical consultant diagnosed an inter-lobar empyema on the right side. Pus was not found on aspiration and an intercostal incision was made over the eighth interspace, without revealing pus in the pleural cavity. Two days later, the child's condition not having improved, the former incision was reopened and an exploring needle revealed pus beneath the diaphragm. Trans-pleural drainage was instituted, drainage was profuse, and the child gradually sank and died seven days later.

Probably the most interesting factor in this case was the fact that the subphrenic abscess was associated with the attack of pneumonia and arose apparently as an independent factor and not as the result of an empyema which had perforated the diaphragm. In this case the X-ray failed to demonstrate the condition, and our records show that in nine cases subphrenic abscess was recognized by X-ray before operation—in two it failed to do so, and in seven, for one reason or another pre-operative X-ray examination was not made, the condition probably not being suspected.

The question of the time interval between the original operation and the recognition of the subphrenic abscess varied considerably, and we were under the general impression that such abscesses usually make themselves manifest anywhere from two to three weeks after the original surgical interference. In this small series the earliest abscess was drained three weeks, and the longest period was eleven months after the primary operation, most of the cases falling between six and ten weeks.

In this respect there is, of course, the possibility that the condition existed earlier than the recorded time of its recognition, but if so, it was purely a question of failure to make a correct diagnosis. As evidence of the difficulty in this respect, in this series a correct pre-operative diagnosis was made in only seven instances; four times it was definitely wrong and

in seven it was not made at all, which latter group should be included in the mistakes, thus giving a percentage of thirty-eight correct—certainly nothing of which to be proud.

In this connection, and also demonstrating the fallacy of making a diagnosis of hysteria, the case of J. C. stands out quite vividly. He was a Hebrew of twenty-two, an actor by occupation, who, four weeks previous to his admission, noticed a swelling of his thigh. An abscess of the soft parts in this region was drained at this time. One week later he complained of severe pain over the right kidney, accompanied by sweating, without, however, presenting any other urinary symptoms. The history notes state that for years he had had symptoms of mild appendicitis. He was a poorly nourished man, examination being essentially normal aside from the fact that his liver was palpable about 3 centimetres below the costal margin, and he had a draining sinus in the right thigh. Aside from the palpable liver, there was neither mass, tenderness nor rigidity demonstrable in the abdomen. There was some tenderness over the right kidney without evidence of bulging or oedema. Temperature, pulse and respiration were 99⁴, 108, 28; leucocytes 30,500. Suspecting a perinephric abscess, an incision was made in the right loin and a normal-appearing kidney exposed. The abdomen was then opened through a right rectus incision and the liver was found to be considerably enlarged, extending halfway to the umbilicus and being smooth, tense and somewhat less firm than normal. The gall-bladder appeared to be normal and a chronic, somewhat adherent appendix was removed.

Two days later he still complained of pain in the right upper quadrant of his abdomen and it was at this time that it was suggested that he was probably of the hysterical type. Six days after his abdominal exploration an aspirating needle inserted through the eighth interspace revealed pus and resection of part of the eighth rib was immediately done. There was no pus in the pleural cavity, but it was obtained by aspirating through the diaphragm, revealing an unsuspected subphrenic abscess. He was drained and did splendidly for eight days—then developed pain in the left thorax, became quite toxic and died on the eleventh day after draining his abscess. A post-mortem was not obtained. This case is rather typical of those in which the diagnosis of subphrenic abscess was either wrong or not made.

In only one case was there the suggestion that an empyema had perforated the diaphragm and from a review of other recorded series this is comparatively a rare complication. Association of subphrenic abscess with disease of the biliary tract occurred in only two patients, one of whom presented some rather interesting features.

An Italian man of thirty-four gave a history quite typical of infectious cholecystitis of twenty-two days' duration, being more acute for the twelve days preceding his admission to the medical wards—continuous upper right abdominal pain, daily vomiting, chills, fever, jaundice and leucocytosis. Except for jaundice, physical examination was essentially negative aside from the abdominal findings. He showed rigidity of the right rectus, slight generalized abdominal tenderness, liver not definitely palpable, spleen not palpable. He appeared quite toxic, and both Widal and blood culture were negative. Six days after admission abdominal exploration was done, revealing dense adhesions in the upper right quadrant, the gall-bladder being adherent to the gastrocolic omentum. The liver was quite normal and stones could not be palpated in the gall-bladder or ducts. The wall of the gall-bladder was apparently not much thickened and a cholecystostomy revealed only inspissated bile, pus not being present. The diagnosis was infectious cholangitis. He reacted fairly well from the operation and nine days later showed dullness and diminished breath sounds at the base of his right

SUBPHRENIC ABSCESS

chest, accompanied by chills and free drainage from the gall-bladder. Three weeks later a subphrenic abscess was suspected and aspiration in the sixth intercostal space, mid-axillary line, obtained pus. Operation through the chest revealed foul, bile-stained pus coming from a walled-off tract which led inward toward the liver. The diaphragm had been markedly elevated, being above the incision (sixth interspace) and a hole was demonstrated leading from the pleura, through the diaphragm, to the liver. He reacted poorly and died three days later. Post-mortem revealed localized peritonitis about the abdominal incision and in the region of the gall-bladder. The small gut was firmly bound together in this region with the formation of an abscess directly beneath, in the retroperitoneal spaces. On breaking into this, a direct connection with the portal vein was found, leading from the abscess cavity directly into the liver. Many scattered abscesses were found throughout the liver. The gall-bladder showed no distinct changes aside from the operation. The chest contained a litre of fluid, and there was a hole in the diaphragm.

The pathologist was unable to demonstrate any area in the liver surface which would seem to indicate that there had been a rupture of a hepatic abscess, into the subphrenic region, and the infection of his upper abdomen probably resulted from leakage of infected bile into the peritoneal cavity by way of the drained gall-bladder, with subsequent formation of a subphrenic abscess which perforated his diaphragm. If this surmise be correct, it serves to emphasize one of the unfortunate complications which may attend drainage of the infected biliary tract, but the surgeon usually does not have much choice under such circumstances, drainage of the tract being requisite.

The question of surgical approach to the abscess varies with the suspected origin and location of the collection—thus when its source is retroperitoneal, *i.e.*, from a perinephric abscess, etc., we believe the best results will be obtained when the approach is from below the diaphragm. Should it be suspected that the abscess occupies one of the anterior suprahepatic spaces, presenting in the upper abdomen, the transabdominal route is preferably the method of choice. In most of the cases, however, presenting on the upper right aspect of the liver we believe that resection of the tenth or eleventh ribs with walling off of the pleural cavity from the drainage tract • and direct drainage through the diaphragm, is the method of choice.

Reflection upward of the pleura in the costophrenic angle, with drainage from beneath this reflected pleura, is probably ideal if it can be accomplished, but it has been our experience that due to adhesions of these layers to the diaphragm and chest wall caused probably by the inflammatory reaction resulting from the abscess, this method is more theoretical than practical. Realizing the importance of preventing infection of an uninvolved pleura, we regard it as of the utmost importance to endeavor to avoid this by securing adhesions between the diaphragmatic and costal layers of the pleura by suture, pack, or both, when such adhesions are not already present. In but few instances will it be found that drainage is so urgent that a delay of a few days will not be warranted to accomplish this walling-off process.

In those cases where immediate evacuation of pus seems indicated, after suturing the two layers of pleura a sufficient amount of pus can be aspirated to relieve the toxic symptoms and tide the patient over the short period necessary to secure firm adhesions and protection of the pleura.

There were eight deaths in this group, a mortality of 44.4 per cent., which is about the average of other recorded series.

In addition to those fatalities already enumerated, a woman of sixty, following cholecystostomy with removal of stones, developed pneumonia sixteen days after operation, went on to empyema, the pus being of colon origin. This was drained and her original abdominal incision was reopened three weeks after the original operation, and 250 cubic centimetres of foul yellow pus removed. She did fairly well and then died suddenly four weeks later from acute cardiac dilatation. Post-mortem revealed the undiagnosed subphrenic abscess, her pleura having cleared up quite well.

A second case, as the result of a draining appendectomy sinus of one year's duration, showed at post-mortem abscesses of the spleen and left lobe of the liver, in addition to a subphrenic one on the left side.

The seventh case was a man of sixty-four suffering from an annular carcinoma of the sigmoid, whose long period of digestive troubles was attributed by the internist to hysteria (and this in 1924) when the röntgenologist stated that there was no evidence of an intestinal lesion nor gall-stones. The colon was slow in emptying without, however, signs of obstruction being present. This was in April, and three months later a caecostomy was done to relieve his intestinal obstruction. Leakage occurred, from which he developed a subphrenic abscess and he died. Among the interesting facts brought out in the case was the failure to recognize an early carcinoma of the sigmoid, and again the danger of attributing symptoms to hysteria merely because the underlying pathological condition has not been ascertained.

A colored boy of seventeen was admitted to the hospital in April, 1930, with a diagnosis of appendiceal abscess. In 1927 he had been operated upon for a right perirenal abscess, pus not being found at the time of operation but subsequently draining from the wound eight days later, to be followed by a right empyema thoracis, which was drained by rib resection.

The next year he was admitted for pneumonia, and pleurisy with effusion, which did not require drainage.

Operation in 1930 revealed an acute appendicular abscess extending in the loin to the site of the old operative scar of his former kidney exposure, suggesting that the former perirenal abscess was due to a perforated appendix and not to any renal involvement. Drainage through his appendectomy incision was not satisfactory and three weeks later through and through drainage to the loin was established. He developed metastatic abscesses of the abdominal wall and right thigh. Six weeks after his appendectomy signs of subphrenic abscess appeared which cleared up, only to reappear three weeks later. At this time aspiration in the eighth interspace revealed a collection of turbid fluid beneath the diaphragm, which was drained through the diaphragm, a portion of the eighth rib being resected in the mid-axillary line. Four hundred cubic centimetres of fluid were removed, which proved to be sterile on culture, and continued so in spite of a faecal fistula developing through the appendectomy wound, the latter due probably to the bowel being perforated in exploring for a pus collection in the abdomen. In three weeks the drainage from the subphrenic abscess had ceased, the faecal fistula continuing.

The boy presented other features of interest, such as an acute post-operative psychosis, small pulmonary embolism, and acute nephritis, and he gradually wasted away and died a little over five months after his admission.

The X-ray showed the collection beneath the diaphragm, and the laboratory reported an acute suppurative appendix. Four blood cultures were negative.

Post-mortem failed to reveal any evidence of tuberculosis. It showed an old inflammatory condition which obliterated the right pleural cavity and evidence of a healed subphrenic abscess. A faecal fistula was present and a walled-off collection of pus in his pelvis, the abdomen being uninvolved.

SUBPHRENIC ABSCESS

The above series is of course too small to warrant any conclusions, but among the facts which have impressed themselves may be mentioned:

1. One of the most frequent causes for failing to detect a subphrenic abscess is failure to consider its existence, and in this connection one should bear in mind that quite a fair proportion of these abscesses arise from causes other than infection within the abdomen.

2. The difficulties often encountered in arriving at a correct diagnosis.

3. One should not hesitate to use an exploring needle when circumstances warrant it and a correct diagnosis cannot be made by other means (physical examination and X-ray).

4. That the X-ray, while a great aid in establishing a diagnosis of subphrenic abscess, is by no means infallible.

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THE MANAGEMENT OF PATIENTS WITH GASTRIC AND DUODENAL ULCERS*

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A GREAT deal has been written about the medical versus the surgical treatment of patients with gastric and duodenal ulcers, with a high percentage of cases failing to get relief from symptoms after each type of treatment. It is not the purpose of this paper to lay down dogmatic rules for the treatment of ulcers but to say that both medical and surgical methods have their place in certain stages of the disease.

Etiology.—As in the case of any other disease, for example, cancer, until we find the causative agent, or agents, our treatment is more or less palliative whether it be medical or surgical. Infection seems to play a very important rôle and Saunders⁶ has recently isolated from excised ulcers an alpha streptococcus of the non-hæmolytic type which seems to have a definite bearing on the cause of the disease. There are probably other factors, such as vitamine deficiency, and this is illustrated by Holt⁴ and Veeder⁷ in their reports on cases of ulcers occurring in infancy. These were usually found before the sixth month and in marasmic infants with a general lowered vitality. Whether acidity is a causative factor in the disease or results from the disease is far from settled, but our laboratory work does not always reveal hyperacidity in cases of proven ulcers. It would seem that hyperacidity is an incidental finding in the disease and bears no etiological relationship.

Our primary interest as clinicians, whether we be internists or surgeons, is to cure the disease or at least to relieve the patient of his symptoms. We do not consider ulcers a simple medical or surgical condition but one in which both methods of treatment may have to be used. It is essential to remember that a patient with an ulcer has a chronic recurring disease characterized by attacks of pain which occur at irregular intervals. The intervals between attacks may be from a few weeks to several months, and at times years.

In the Gastroenterological Clinic of the Fourth Medical and Surgical Divisions of Bellevue Hospital from January, 1928, to April 1, 1930, there were 238 ulcers under observation. Of this number thirty-nine have been operated upon for acute perforations and forty-four for chronic ulcers, leaving 155 unoperated ulcers. Of the unoperated cases there were 124 duodenal ulcers, fifteen gastric ulcers, twelve pyloric ulcers and four double ulcers, meaning the patient had lesions in both the stomach and duodenum. Our object has been to relieve the patient of symptoms and, if possible, to cure the disease by medical care, employing surgery only as a means of last resort.

The patients, on entering the clinic, are referred for X-rays of their teeth

* Read before the Delaware County Medical Society, Delhi, New York, June 10, 1930.

GASTRIC AND DUODENAL ULCER PATIENTS

and extractions are done if necessary. If there is an indication of sinus or throat infection they are referred for X-rays and examination. A gastric analysis, complete blood count, Wassermann, urine and blood chemistry for urea nitrogen, creatinine, sugar, chlorides, calcium and phosphorus determination is done. In bleeding cases blood-platelets, bleeding and clotting, and clot retraction time is done. X-rays of the gastro-intestinal tract are done at frequent intervals.

The dangers from an ulcer are: first, perforation; second, hæmorrhage; third, carcinomatous degeneration. Perforation is a real danger and patients may perforate more than once and even after they have been under prolonged medical care and are apparently progressing satisfactorily. In a recent paper³ read before the American Gastroenterological Association in which 105 cases of acute perforated ulcers were reported, there was noted an increase in the incidence during the past few years. In 1911, there was one case, as against thirteen for 1929. Also, six cases have occurred during the past two years while under medical care in our clinic. The only means of preventing this complication is to find the cause of the disease. Saunders,⁶ by his agglutination test, seems to be in a position to aid in the diagnosis and to prognosticate the course of the disease.

Hæmorrhage is an alarming complication of ulcers. Gastric hæmorrhage will at times prove fatal in spite of every effort to save the patient by transfusions and conservative measures. There have been fifty-two cases of bleeding ulcers admitted to the Fourth Surgical Division since 1911, with six deaths in cases not operated upon but treated conservatively. It is interesting to note that these severe hæmorrhages occur in patients with a negative gastric history and the first warning is profuse bleeding. The chronic recurring hæmorrhages do not prove fatal and should have every chance of medical care, although we have had six cases of hæmorrhage occur in the clinic in patients under medical management that were progressing satisfactorily, but these cases have been controlled by transfusions and rest. There are also four cases that have been operated upon for bleeding ulcers which have continued to bleed. The operations varied from gastrectomies to gastroenterostomies and pyloroplasties. The best procedure is to treat the case conservatively, but if it continues to bleed over a long period, an operation should be performed and the ulcer cauterized or excised, plus whatever other procedure may seem advisable.

Carcinomatous degeneration may occur in gastric ulcers but it never occurs in duodenal lesions. Granting that it does occur in gastric lesions it is doubtful if the percentage is as high as some clinics estimate. MacCarty⁵ has stated that about 70 per cent. of chronic gastric ulcers present cells of the cytologic appearance of cancer. Ewing² puts the incidence around 2 per cent. It is difficult to believe that the incidence of carcinomatous degeneration of gastric ulcers exceeds 10 per cent. If one employs gastrectomies routinely in cases of gastric lesions, the mortality will be at least 15 per cent. It is interesting to note that Balfour,¹ in his report on surgery of the stomach

and duodenum in the Mayo Clinic for 1929, operated upon 125 gastric ulcers. Of this number approximately 40 per cent. had partial gastrectomies; 35 per cent. excision with cautery or knife and gastroenterostomy; and 15 per cent. gastroenterostomy alone. We do not consider a gastric ulcer an operative case unless it fails to respond to medical care. An early gastric lesion responds to medical management more favorably than a duodenal ulcer.

Treatment.—All ulcers are considered as inflammatory lesions, regardless of location, and are treated by medical care, and surgery is resorted to if the case does not improve. An early carcinoma with an ulcerative area might be mistaken for a gastric ulcer but these cases do not respond to medical treatment.

The patients are treated in one of three ways: (1) ambulatory Sippy diet; (2) vitamins, vaccines and bland diet; (3) surgery.

That the ambulatory Sippy treatment has a definite place in cases of ulcer seems certain. Doctor Bishop supervises the ambulatory cases and will report on his results at a later date, but so far this method of management has given good results in most instances. Patients can remain on a strict milk-and-cream diet for several weeks, if they are not doing laborious work, and continue at their occupation without any hardship. Even though the patient can receive free hospital care for four to six weeks, due to economic problems at home, he does not get the mental rest which is essential in these cases. Doctor Hartung is using vaccines and vitamins on another group with some very satisfactory results. He has some early cases that have not been treated by other methods, and others that have failed to receive relief from symptoms after a Sippy diet, or following operations of different types. These cases are at times changed from one type of medical treatment to another. Doctor Hartung will report in detail on his work at a later date.

Surgery.—It has been our intention to operate on cases as a last resort only and so far we have had but five operations in chronic ulcers that we have treated. It is not our intention to state whether pyloroplasties, gastroenterostomies or partial gastrectomies should be performed, but we have cases under observation that were failures in all three types of operation that have been done in other institutions. The indications for operation, such as pyloric obstruction, long history with previous treatment, recurring hæmorrhage and gastric ulcers have been ignored, and all of these cases have received medical care before considering operation. The cases that have been operated upon so far have progressed very satisfactorily and most of them have had conservative types of operation, such as pyloroplasties or gastroenterostomies. If the cases are given a chance of medical management, the results from surgery in the medical failures would seem to be very gratifying.

SUMMARY

No conclusions can be drawn at present, but if one approaches this problem with an open mind, he will see some of the most startling results from both medical and surgical treatment in cases in which a good result is

GASTRIC AND DUODENAL ULCER PATIENTS

least expected. Also, failures are encountered with both methods of treatment when we had every expectation of a good result. A patient cannot be considered cured until kept under observation for a ten-year period, whether medical or surgical treatment is advocated.

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**DUODENO-JEJUNOSTOMY AS A SUBSTITUTE FOR GASTRO-
ENTEROSTOMY IN CERTAIN CASES OF DUODENAL
AND GASTRIC ULCER AND APPARENT
OBSTRUCTION OF THE STOMACH**

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THE operation of duodeno-jejunostomy, an anastomosis between the first loop of the jejunum and the third, or the second portion of the duodenum, and for the purpose of regularly emptying the duodenum above a stenosis located at its lower part, has been widely popularized through the journals and Quain's¹ monograph on the duodenum. The brilliant results of recent duodeno-jejunostomy in chronic or recurring duodenal obstruction have been amply proven by case reports in the literature.

Sloan³ proved the presence of periduodenal adhesions by operation in 362 cases and found a co-existing duodenal or pyloric ulcer fifty-two times. From these observations he concludes that partial duodenal obstruction at the duodeno-jejunal angle is sometimes the cause of duodenal ulcer or that it creates conditions favorable for ulcer formation. He obtained several cures of the ulcer by simple removal of the obstruction without gastroenterostomy. Kellogg⁴ and I observed five cases of duodenal ulcer with duodenal stasis. In six cases the ulcer was active; in two of Kellogg's and one of Quain's, stenosing in Wilkie's. Wilkie reported a perforated duodenal ulcer. In a case of Deaver there were four perforations, with three operations of suturing and recovery, but death after fourth perforation. The autopsy showed an unsuspected obstruction of the duodenum above the mesenteric artery. Wilkie⁵ again reported three cases, Higgins⁶ five cases of duodenal ulcer as complications in duodenal stasis, and Barling⁷ and Zoepffel⁸ five and two cases respectively of gastric ulcer accompanying duodenal obstruction. Lane⁹ restated his theory that duodenal stasis may produce either ulcer of the duodenum or stomach. Berg, Melaney and Jobling,¹⁰ in their experimental studies after the production of a lasting duodenal obstruction with dilatation above and confirmed by fluoroscopic examination, noted, as well, an enormous increase in bacterial flora, mostly in the bacilli of the colon group.

Gastric retention and dilatation of varying degree is not uncommon, along with duodenal stasis, and has been noted by most writers on the subject. In a case of Stavely's and Wilkie's the gaping pylorus admitted several fingers. Moynihan¹¹ has pointed out that duodenal obstruction is a cause of the so-called "vicious circle" and Wilkie also stresses this point, as well as the point that recurrent symptoms after gastroenterostomy are due to unrecognized duodenal obstruction at the time of operation. Zoepffel likewise attributes some bad results after Billroth No. I to the fact that stenosis of the third portion of the duodenum had been unrecognized.

Quain makes the significant remark that it is, therefore, necessary always to verify the condition of the duodenum when a gastroenterostomy is made for gastric or duodenal ulcer.

DUODENO-JEJUNOSTOMY

CASE I.—A man, aged thirty-five, with typical symptoms of duodenal ulcer, who, in spite of irregular Sippy and antacid diet, belladonna and alkalies, had profuse vomiting of blood, improved and hæmorrhage ceased after medical treatment. Filling defect persisted. (Case I, Fig. 1) gastroenteroptosis and dilated duodenum. Finney pyloroplasty with resection of ulcer; pathological report of malignant ulcer (discredited), symptom-free for eighteen months, usual confusing shadow-graft following pyloroplasty. (Case I, Fig. 2.) Sudden recurrence of symptoms and acute perforation; perforation cauterized and closed, gastroenterostomy to relieve tension in duodenum; symptom-free for fourteen months; recurrence of pain in epigastrium and tenderness, ulcer at gastro-jejunal anastomosis.

CASE II.—Woman, aged sixty-two, pain in epigastrium, occasional vomiting. Two X-ray series with barium enemata and visualization of gall-bladder, showed only gastroenteroptosis and moderately dilated duodenum. Improvement of short duration



FIG. 1.—Case I. Persistent ulcer after hæmorrhage, ulcer clearly visible and palpable at operation resected. Finney pyloroplasty.

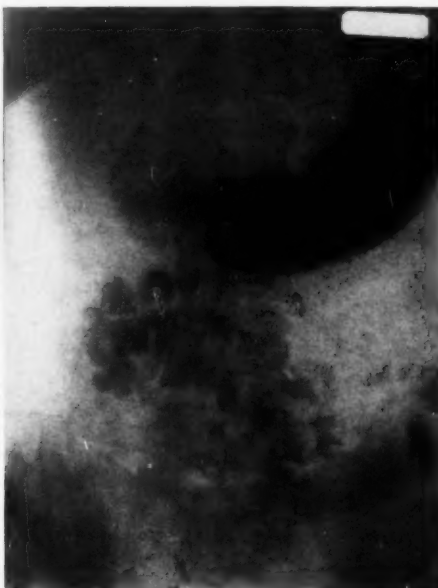


FIG. 2.—Case I. After Finney pyloroplasty and resection of ulcer, dilatation of duodenum, recurrence of ulcer and perforation. Cauterization and closure of ulcer and gastroenterostomy. Recurrence of ulcer from stasis and tension likely prevented by duodenojejunosomy and resection of ulcer. Marginal ulcer after gastroenterostomy to be closed and duodenojejunosomy.

on belladonna, alkalies and antacid diet, attacks of pain in epigastrium recurred from time to time over a period of four months' observation, finally passed blood by bowel and vomited blood. X-ray study showed dilated and deformed duodenum. (Case II, Fig. 3.) At operation dilated duodenum, ulcer in second portion of duodenum, relieved of pain by gastroenterostomy for eight months to date. *Impression.*—Same relief of symptoms and likely more enduring comfort by duodeno-jejunosomy.

CASE III.—Man, aged forty-eight; weight, 106 pounds, loss of forty pounds in weight, pain in epigastrium, frequent attacks of nausea and voluminous vomiting, pale and weak. X-ray study showed dilated duodenum, dilated stomach with eleven hours' gastric retention. (Case III, Fig. 4.) At operation bands of adhesions at terminal duodenum and rolling and narrowing of duodenum, dilatation of proximal duodenum.

ADDISON G. BRENIZER

Duodenum liberated and anastomosis made between first loop of jejunum and infra-mesocolic duodenum. The patient never vomited again, was on a full diet in the course of three weeks and according to his own statement remains perfectly well with a weight of 160 pounds, eating what and when he wants. Now remains well for six years. A defect in cap shown in X-ray and diagnosed ulcer was not found at operation as a visible and palpable ulcer.

CASE IV.—Woman, aged thirty-two, thin, pale; frequent attacks of nausea and voluminous vomiting. X-rays showed moderately dilated duodenum and stomach, gastric retention for eleven hours. A gastroenterostomy was done. After operation there was frequent vomiting of large quantities of bile-stained fluid, so-called "vicious circle." The vomiting was relieved by elevating the foot of the bed. Vomiting frequently occurred during six months and there was no improvement. Repeated X-rays showed markedly dilated duodenum and stomach and prolonged gastric retention. (Case IV, Fig. 5.)



FIG. 3.—Case II. Deformed and dilated duodenum, ulcer found at operation in second portion of duodenum, bulging near cap an artefact after violent hæmorrhage. Two former X-ray studies negative. Relieved by gastroenterostomy. Stasis and tention in duodenum would have been better provided for by duodenojejunostomy.



FIG. 4.—Case III. Duodenal obstruction by adhesions and rolling of terminal duodenum. Nitch in cap diagnosed ulcer, not visible and palpable at operation. Completely relieved for six years by duodenojejunostomy.

Second operation the terminal duodenum was surrounded by adhesions and narrowed and the terminal loop jejunum used for gastroenterostomy carried to the left; made a sharp angle at the duodeno-jejunal junction. A duodeno-jejunostomy was done. There was no more vomiting, a rapid gain in weight and marked relief but multiple neurotic complaints, such as irregularity of menstruation, pain in hips, *etc.* X-rays after duodeno-jejunostomy showed stomach emptying in four hours and rapid passage into cæcum (Case IV, Fig. 6.)

CASE V.—Woman, aged forty-two, thin, pale; frequent attacks of voluminous vomiting. History of possible tuberculous peritonitis when a child, formerly had cholecystectomy. X-rays showed dilated stomach and duodenum with nine hours' gastric retention, gastroenteroptosis. At operation there were multiple bands at terminal duodenum, marked angulation at duodeno-jejunal angle, and membrane holding terminal duodenum

DUODENO-JEJUNOSTOMY

and proximal jejunum together. At operation, that duodenum and stomach be surely relieved of obstruction, the duodeno-jejunal angle was liberated from bands and membranes and also from the ligament of Trietz and the anastomosis made between gastric antrum and the duodeno-jejunal junction. The patient improved, gained weight but soon had an occasional return of attacks of vomiting and some diarrhoea. The stomach and duodenum now empties about as fast as the barium meal can be given. (Case V, Fig. 7.) The gastric contents rapidly fill the small intestine and by rapid overloading, vomiting recurs. *Impression.*—At the operation a duodeno-jejunostomy would have sufficed. The question is now before us of taking down the gastroenterostomy and making a duodeno-jejunostomy.

CASE VI.—Woman, aged forty-two; attacks of pain in epigastrium as well as pain in right lower abdomen, profuse menstruation, vomiting, elevation of temperature and leucocytosis, negative urine. Poor result with enemata. Brought to hospital as acute



FIG. 5.—Case IV. Markedly dilated duodenum "vicious circle" after gastroenterostomy, due to adhesions and falling of jejunal loop to the right followed by persisted duodenal obstruction completely relieved by duodenojejunostomy at second operation.

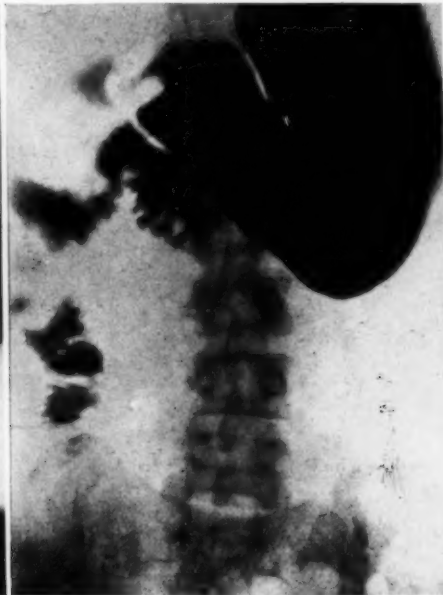


FIG. 6.—Case IV. Rapidly emptying duodenum and stomach in Case IV. Fig. 5 after duodenojejunostomy.

abdominal case and diagnosis of ovarian cyst, was formerly operated on for tuberculous spine with bone graft and appendectomy. Abdomen flat, scar of former appendectomy, tenderness and definite resistance over cecal region, soft mass over right adnexa, small mass over left adnexa. *Diagnosis.*—Ovarian cysts right and left, partial intestinal obstruction. At operation ovarian cyst size of lemon on left side. Cæcum down in right side of pelvis, filled with soft doughy fecal matter, ascending colon adherent to peritoneum, at site of former appendectomy. Colon liberated from abdominal wall, enucleation of left ovarian cyst. Patient vomited after operation large quantities of bile-stained fluid, in spite of good results following enemata on the second and third days and continued to vomit in spite of the fact that the abdomen remained soft. After a large enema and turning the patient over on her abdomen with foot of bed elevated, there was a cessation of vomiting and a sudden movement of bowels filling the bed. The patient was sustained on salt solution and glucose given in frequent and large

ADDISON G. BRENIZER

quantities intravenously during her vomiting. By the fifth day she was entirely comfortable and taking food. *Impression.*—Duodenal arterio-mesenteric ileus ("acute dilatation of stomach"). Compare with Case IV, Figs. 5 and 6, and so-called "vicious circle" following gastroenterostomy.

CASE VII.—Woman, aged sixty-nine; indigestion and dyspepsia number of years, getting worse lately, loss of color and forty-two pounds in weight. Recently has been using stomach tube for washing out stomach on account of gastric distress. Vomited large quantity of blood, estimated at quart to quart and half and still passes tarry stools. Thin, pale, hæmoglobin 40 per cent., general examination negative, given blood transfusion. Tender over right upper abdomen, mass felt in right hypochondrium and epigastrium. X-rays show irregular mass in antrum. At operation in antrum and extending to pyloric ring irregular mass with puckering of gastric wall and adhesions, size of lemon, with cap-like crater located in anterior wall nearer greater



FIG. 7.—Case V. Gastroenterostomy between detached duodenojejunal junction and stomach in case of duodenal obstruction. Extremely rapidly emptying stomach, vomiting and colitis. Advised closure of gastroenterostomy duodenojejunostomy.



FIG. 8.—Case VII. Following resection of over half the stomach for carcinoma in woman sixty-nine years old, six years ago. Never vomited after operation, gained 42 pounds in weight. Eats full diet with absolute comfort. Stomach empties in 1 to 1½ hours. Compare with Fig. 7, Case V.

curvature. Part of corpus, antrum and first portion of duodenum resected and anastomosis of the Polya type done. Gross specimen showed ragged ulcer with indurated base and edges. Pathological report of ulcer with carcinomatous changes. There was never any vomiting after operation, patient left hospital in sixteen days on soft diet, reached full diet within two months and has been in good health and comfort for six years, since January 31, 1924. (Fig. 8.)

In six of the above cited seven cases, pain, vomiting and loss of weight were prominent in all of them. Cases I and II vomited large quantities of blood, and Case III occasionally a small amount of blood. Cases III, IV and V had numerous attacks of voluminous vomiting and showed prolonged gastric retention and considerable dilatation of the stomach. Persistent X-ray studies finally exhibited dilatation and deformity of the duodenum, and in

DUODENO-JEJUNOSTOMY

Cases I and II ulcer of the duodenum was found both by X-ray studies and at operation, but the ulcer diagnosed by X-rays in Case III was not found at operation. Case I had a recurrence of ulcer and perforation after pyloroplasty and resection of ulcer and was temporarily relieved by closure of perforation and gastroenterostomy, but later developed a marginal ulcer at the stoma of the gastroenterostomy. Case II showed ulcer in second portion of duodenum at operation and has been relieved by gastroenterostomy. It was suggested that duodeno-jejunostomy, followed by resection of the ulcer, would have been the operation of choice in Cases I and II, as was done with perfect result in Case III, to relieve stasis and tension in the duodenum, and would likely have prevented recurrence and perforation in Case I and secured more permanent result in Case II. Case V was overdone and the effect produced was that of combined gastroenterostomy and duodeno-jejunostomy; Case VII showed less rapid emptying of stomach after result and satisfactory X-ray study. Case IV was a failure after gastroenterostomy, had "vicious circle," and persisting duodenal obstruction. Both cases should have received a duodeno-jejunostomy alone at the first operation. Case VI developed the so-called "acute dilatation of the stomach" after operation in the lower abdomen and was immediately relieved by posture, as was Case IV. Duodenal obstruction, "vicious circle" and "acute dilatation of the stomach" are frequently one and the same thing.

May I insist that it is rather definitely and clearly pointed out by the above seven cases and remarks that the best results have been obtained, where the ulcer is resected and where the point of obstruction is searched for and found and proper relief of stasis and tension cared for, by the drainage of the upper into the lower portion of the gastro-intestinal canal at that particular location. This particular location of obstruction is frequently in the terminal duodenum and the logical site of anastomosis is between duodenum and jejunum.

It seems, according to Quain, that Petit in his thesis on the "Strangulation of the Duodenum at the Level of the Mesenteric Root" (Paris, No. 67, 1900), was the first to conceive the operation of duodeno-jejunostomy and to perform it on the cadaver. Baker, according to Wilkie, was the first to propose it, in 1906. Staveland, in 1908, put into practice the first transverse colic duodeno-jejunostomy on the living, for a chronic occlusion of the duodenum by the mesentery.

About half a century has elapsed since the foundation of gastric operations and yet hardly a single revolutionary method, except duodeno-jejunostomy, has been developed during that time. Technical modifications and improvements have been added but the principles of enlarging the pyloric orifice as laid down by Heineke-Mikulicz, the gastrojejunal anastomosis of Woelfler and the gastric resections of Billroth remain the basal procedures. It is likely that none of these operations or their modifications have more than a mechanical action beyond the removal of the growth and that no enduring physiological basis has been established beyond the drainage of the higher into the lower portion of the gastro-intestinal tract and that this prin-

ciple of relieving stasis satisfies all surgical requirements and yields, where clearly indicated, satisfactory results.

In making the above statement I have taken into full consideration the works of Alvarez, and his description of the motion pictures and of Cole's studies of "The Living Stomach and its Motor Phenomenon." I admit the importance of a knowledge of the complicated motor function of the stomach and duodenum, the secretory function and even the nerve supply, as well as the confusion in terminology, such as "duodenal cap" for pyloric cap and the proper location of corporic, pre-pyloric and post-pyloric ulcers. But when all is said, the surgeon's problem is centred on evacuation of the stomach and duodenum regardless of the procedure employed for the removal of the lesion.

The process of evacuation of the normal stomach is described by Cole as follows:

"The chyme in the stomach is moved along from one chamber to another by the progressive peristalsis, there being some intermingling of the chyme of the corpus with that of the antrum. The fluid chyme is squirted through the pyloric valve into the reservoir cap and separated from the rest of the chyme in the stomach. The fluid chyme is taken out of the top or distal end of the cap by a broad peristaltic wave which carries it through the duodenum and probably continues throughout the small intestine. The frequency and activity of this broad peristaltic wave is the fundamental phenomenon which governs gastric evacuation. Gastric tone only presses the chyme against the under surface of the cap. Progressive peristalsis, modified by systole and diastole, no matter how strong, only squirts the chyme through the lumen of the valve into the cap. The pyloric canal closes with a definite sphincteric action, but it is closed for such a very short period of the gastric cycle that it does not normally prevent gastric evacuation, and if anything it possibly accentuates it by squirting a small amount of chyme through into the cap when it contracts. The pyloric valve tends to retain the solid food in the antrum and to allow the more fluid content to be squirted through into the cap. But if all these are functioning normally and actively, unless there is a broad peristaltic wave to propel the chyme from the top of the cap and carry it through the duodenum in finger-like masses, functional gastric retention ensues. Therefore we must reiterate that the broad peristaltic wave in the duodenum is the fundamental phenomenon which controls gastric evacuation."

It becomes immediately evident that if the broad peristaltic wave in the duodenum takes place in its progressive fashion from cap through the duodeno-jejunal junction into the small intestine, this route must be ever patent and obstruction of the duodenum will not only be followed by stasis and increase in bacterial flora but will markedly disturb the whole gastric motor mechanism. This condition is actually observed in cases of duodenal obstruction where violent antiperistaltic waves are seen in the dilated duodenum, the pyloric canal stands wide open and antiperistaltic waves traverse the stomach as vomiting takes place, and duodeno-jejunostomy may completely relieve this condition and restore gastric motor function. The operation chosen for draining or evacuating the stomach should respect the motor function of the stomach and the selective action of the pyloric valve and should assure the patency of the terminal duodenum. This last condition, patency of the terminal duodenum, is the most important factor.

DUODENO-JEJUNOSTOMY

(Fig. 8, Case VII.) In this case, though of a necessity, cap. antrum and most of the corpus of the stomach were resected on account of cancer, with a patent duodenum, clinically the stomach functions perfectly and is shown satisfactorily by X-ray studies. Compare Fig. 7, Case V, where the chyme is hurled through the gastroenterostomy into the small intestine with such rapidity that the brunt of volume causes overfilling, antiperistalsis and vomiting. This emptying of the stomach more or less rapidly, has been in large part the fault in a considerable percentage of my cases where gastroenterostomy was done. In this case, as well as in Case IV, Figs. 5 and 6, duodeno-jejunosomy alone should have been the operation first done. Both cases now have duodeno-jejunosomy plus gastroenterostomy; the latter, with satisfactory result, and the former, a failure due to too rapid emptying of the stomach. Certainly duodeno-jejunosomy alone would have attained better results in both cases and at the same time retained the motor function of stomach and duodenum as described by Cole.¹² Likewise, duodeno-jejunosomy alone or duodeno-jejunosomy with resection of the ulcer would have relieved the stasis and tension in the duodenum, and hence bacterial growth, would have preserved the motor function of the stomach and duodenum in Cases I and II, Figs. 2 and 3, would likely have forestalled the recurrent ulcer and perforation and the marginal ulcer in Case I, would have secured the result in Case II, as was so brilliantly accomplished in Case III by duodeno-jejunosomy alone and at the same time would have preserved the motor function of stomach and duodenum, disturbed by gastroenterostomy.

Zoepffel, quoted by Quain,¹ says that when a gastric ulcer and a stenosis of the third portion of the duodenum coëxist, Billroth No. II is indicated, a pylorotomy, and that Billroth No. I should be abandoned. This conclusion seems absolutely illogical, since with Billroth No. II, as well as with Billroth No. I, the duodenal retention will persist after operation. Whatever gastric operation is made it is indispensable to establish drainage for the chronic retention in the third portion of the duodenum.

The startling report of Cole¹³ of twenty-six cases of gastric ulcer treated surgically and to be compared with thirty-six similar cases treated medically is indeed appalling:

"In the twenty-six cases presented, from verified records, eleven were treated with gastric resection, ten with excision and five with gastroenterostomy without excision. Of the eleven treated with gastric resection, six lived to leave the hospital and five died while in the hospital. Of the ten treated with excision; two were mucosal ulcers and one, as proved by microscopical examination, was already a healed ulcer. Of the remaining seven, two died, two were worse, one improved, and two were said to be improved, but in one of these, even with a special request for a röntgen-ray examination after the operation and before the patient left the hospital, such a procedure was not granted and we were unable to obtain further data. All of the three cases treated with gastroenterostomy lived but as we can compare each of these with a similar case treated medically without gastroenterostomy, the question arises: Did the ulcer heal because of the gastroenterostomy, or in spite of it?"

Compare this report with that embraced in a recent paper by Brenizer¹⁴ where the various operations upon the stomach and duodenum are listed in 108 cases. This list embraced nine cases of gastric resection for gastric ulcer or cancer without a single death in less than a year's time and two deaths from metastasis. Gastric function remained satisfactory in all cases, even in spite of death from metastasis, equal to results in Case VII, Fig. 8. Every living case, seven cases in all, has presented large, visible, and palpable lesions at operation; has been verified by pathological section; has received an anastomosis of the Polya type; has a patent duodenum; and has been frequently seen or heard from during a period of ten years. However this question of operative indications and post-operative results may be, it still holds the "center of cyclonic controversy." This question is not pertinent to this paper except insofar as a failure to recognize an obstruction of the duodenum may prevent the success of an otherwise properly indicated and executed operation whether that operation be simple excision, pyloroplasty, gastroenterostomy or Billroth Nos. I and II. In these cases a combined duodeno-jejunostomy is the only logical operation, and, furthermore, it is a necessary operation. In selected cases of duodenal ulcer, and even gastric ulcer, of the gastroenteroptotic type of individual and with duodenal stasis, relief of tension and stasis can be directly attained and at the same time normal motor function of the stomach and duodenum preserved, by making the anastomosis, rather than between stomach and jejunum, preferable between duodenum and jejunum.

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TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD JANUARY 5, 1931

The President, DR. GEORGE P. MULLER, in the Chair

CALVIN M. SMYTH, JR., M.D., Recorder

TUBERCULOUS PERITONITIS AND RECURRENT UMBILICAL HERNIA

DR. GEORGE M. LAWS presented a patient to illustrate the repair of incisional hernia without removing the sac nor disturbing the viscero-parietal adhesions. A woman, aged fifty-nine years, was admitted to the Medical Ward of the Presbyterian Hospital, July, 1929, complaining of weakness, cough and enlargement of the abdomen. She had been operated upon for strangulation of an umbilical hernia in 1922, but noted recurrence four years later. Her medical history was unimportant thereafter until April, 1929, when she had an acute illness called congestion of the lungs. Since then she had not felt well and a month before admission the abdomen began to grow larger. She weighed 205 pounds; her enormously enlarged abdomen was symmetrical except in the mid-region which was the seat of a recurrent umbilical hernia. Movable dullness and a definite fluid wave were present. Peristalsis was hyperactive.

After two weeks' observation, during which the evening temperature rose to about 101° F., an operation was determined upon.

A transverse incision in the line of the abdominal scar revealed a thick-walled sac which was opened with the escape of a large quantity of dark brown fluid. The intestines, mesentery, liver and spleen were studded with small, white, hard nodules that were proven by biopsy to be tuberculous. The problem of dealing with the hernia then arose. Coils of small intestine were fused with the sac so firmly that herniorrhaphy in the usual way was impracticable. The wound in the sac was closed, the rupture was reduced *en bloc*, as it were, and the repair was completed by overlapping the fascia.

Recovery was complicated by left tuberculous pleural effusion which required aspiration thirty days after operation. The patient was discharged ten days later. She reported recently at the follow-up clinic that convalescence had been satisfactory and that she had remained free of symptoms. Examination showed no abdominal fluid and no hernia.

DR. GEORGE P. MULLER said that he had had occasion several times in the case of large incisional hernia below the umbilicus, to practise a method similar to the one described, without penetrating the peritoneal cavity. After dissecting out the skin scar the dissection is carried laterally until the edges of the anterior fascia have been identified. About one-half inch lateral from the edge of the retracted rectus muscle an incision is made from top to bottom in the anterior sheath. The median edge of this incision on either side is then sutured together in the median line to form a new linea alba, carrying the rectus muscle practically to its original position.

PHILADELPHIA ACADEMY OF SURGERY

The lateral edges are then sutured together, if possible, still further, pulling the recti muscles together in the median line. If the latter suture is not possible the defect of fascia over the muscle is replaced by a fascia transplant from the thigh.

PENDULOUS ABDOMEN—LIPECTOMY

DR. GEORGE M. LAWS reported the case of a woman with a pendulous abdomen from which he removed a segment that weighed twenty-four pounds.

When first examined, in February, 1928, she was twenty-eight years old



FIG. 1.—Pendulous abdomen. Lateral view.



FIG. 2.—Antero-posterior view.

and weighed 362 pounds. Standing, the abdominal wall dropped almost to her knees (Fig. 1), and walking, each step pushed half of the mass forward. The chief complaint was pain, evidently caused by the dragging weight.

A thorough examination had been made by a prominent internist, who found no endocrine disturbance. X-ray of skull, blood examinations, basal metabolism and sugar tolerance tests were all practically normal. She had been taking a gland preparation for a year but was still gaining weight. After seven months of dieting she had lost only eight pounds, and returned for operation chiefly because of the pain.

Operation October, 1928, at Presbyterian Hospital. A transverse bow-shaped incision was made through the skin and fat below the umbilicus,

SUBPHRENIC ABSCESS

because the umbilicus supports these tissues. It was a long operation and the patient was somewhat shocked. Wound healing was primary, except where the tubes emerged and mild superficial secondary infection occurred at two of these places. Recovery and result were entirely satisfactory.

The wedge of tissue measured 37 inches from tip to tip, its greatest width was 14 inches, the average thickness 3 inches.

SUBPHRENIC ABSCESS

DR. HENRY P. BROWN, JR., read a paper with the above title for which see page 1075.

DR. ELDRIDGE L. ELIASON said that he had treated eight such cases in the last seven years, although the essayist stated that he found but eighteen cases in two large hospitals, ten in twenty years in one and eight in the last eight years in another. As to the etiology the speaker remarked that in 1926 he reported twelve cases of liver abscess, ten of which were personal cases, all secondary to appendicitis, occurring from ten days to eleven months previously. In these twelve cases, seven had solitary right lobe abscess. Of these, five had proven subphrenic abscess also. Last week he discharged from the hospital another of the same type, making six in which the two abscesses existed in juxtaposition, as an hourglass cavity. It is well known that solitary liver abscess following appendicitis is probably embolic and that it has a predilection for the right lobe and tends to extend toward the upper surface of the liver. Only two of the above eight were near the under surface of the liver. It is reasonable to suppose that a subcapsular small abscess on the upper surface could also cause a subphrenic collection comparable to the supposed causation of an empyema thoracis following a pneumonia. Bile found in the subphrenic collections indicates this connection. Furthermore, in none of these personal cases was there any evidence of abdominal gutter extension. Another argument in favor of the liver origin is the fact that several of his cases as well as some of Doctor Brown's had no recent cause for the condition, the appendiceal attack or operation being as old as eleven months in one instance. Doctor Brown speaks of a possible thoracic origin only to cast possible doubt upon the same, and the speaker agrees with him entirely. In his liver and subphrenic abscess cases, the first diagnosis was suspected basal pneumonia, with lung changes shown clinically and by X-ray. Again, exploration by needles to the abscess by the Ochsner operation, which consists of the subperiosteal resection of the twelfth rib. In that way one gains entrance to the right posterior and the right interior space. The dissection is not difficult. By the hand one can differentiate the surface of the liver from the diaphragm and avoid any injury to the diaphragm proper; drainage is well maintained.

DR. HUBLEY R. OWEN said that in a case at the Women's College Hospital, which was operated upon about six weeks ago for a simple cholecystectomy, the patient when about to be discharged suddenly developed severe pain in the chest and a rise in temperature to 102-103°. There seemed to

PHILADELPHIA ACADEMY OF SURGERY

be every sign of pleurisy at the base of the right lung. The chest was strapped but there seemed to be no improvement. A few days later an X-ray was taken which indicated that she had an abscess because of the elevation of the diaphragm. Recalling Doctor Eliason's report before the Academy, he opened the abdominal incision and found the liver and the region of the cholecystectomy normal, but the lower margin of the diaphragm was bulging. He went in above and removed about 500 cubic centimetres of fluid which in appearance resembled the fluid from a streptococcus empyema. The patient then made an uneventful recovery. He was very much confused as to the origin of this infection. It certainly did not appear to be from the abdomen and there were no findings in the chest to account for it. Accidentally puncturing the infected subphrenic area secondarily gives empyema. The presence of the colon bacillus argues for abdominal origin, although its absence is no proof against the same; colon pus was found in only one of his cases, the others being coccal. Of the other two cases in his personal series, one was due to an old perforated duodenal ulcer and the other to extension from an acute pancreatitis. These figures, therefore, indicate that appendicitis causing hepatic abscess is the most frequent cause of subphrenic abscess rather than that peritonitis causes it by extension up the flank or by the lymphatics.

Errors in diagnosis will be and are growing less frequent with the proficiency of X-ray reporting. The apparent increasing frequency is merely an increased accuracy in diagnosis and the decreasing mortality is due to the same. These patients no longer die with a suppositional typhoid fever or septic pneumonia.

DR. THOMAS SHALLOW mentioned as an additional fact pertaining to subphrenic abscess secondary phrenospasm, associated with much dilatation of the lower end of the œsophagus. He further emphasized that in diagnosis the X-ray is the most valuable method at our disposal. Of all the cases that he has seen every one that was diagnosed correctly was diagnosed by the use of the X-ray.

DR. BENJAMIN LIPSHUTZ remarked that he had had six cases of subphrenic abscess and in every instance he was able to gain access to the abscess by the Ochsner operation, the subperiosteal resection of the twelfth rib. In that way one gains entrance to the right posterior and the right inferior space. The dissection is not difficult. One can get his hand in and differentiate the surface of the liver from the diaphragm and avoid any injury to the diaphragm proper. Drainage is well maintained.

SURGICAL MANAGEMENT OF CRANIAL INJURIES

DR. J. STEWART RODMAN pronounced the Annual Oration as above entitled, for which see page 1017.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD DECEMBER 10, 1930

The President, DR. EDWIN BEER, in the Chair

ARTHROTOMY OF KNEE

DR. IRA COHEN presented a man fifty-five years old, who in December of last year was brought into Mount Sinai Hospital two hours after being struck by an automobile. He had a lateral dislocation of the left knee, the inner condyle of the femur was prominent and there was considerable abnormal mobility of the joint. The X-ray examination showed a subluxation with mesial displacement of the femur. An irregular shadow was seen overlying the joint space in the intercondylar area which was interpreted as a possible tear of the crucial ligament carrying with it part of the tibial insertion.

Under anæsthesia an attempt at reduction was made the same day and a plaster bandage applied. Reëxamination by the X-ray showed the subluxation to be almost but not entirely reduced, but a good antero-posterior view was not obtained. When the plaster was removed two weeks later, it was seen that a partial subluxation still existed. After another week the patient was allowed on crutches, and at the end of the next week he was referred to the physiotherapy department in the Out-Patient Department. He had very little pain and was able to get about with crutches; motion was limited to approximately thirty degrees.

When he reported at follow-up two months later the leg could not be completely extended at the knee and the motion was more limited than at time of discharge. A month later there was increased flexion deformity, hardly ten degrees of motion was present. There was no change in the Röntgen picture.

April 9, 1930, he was readmitted to the hospital and two days later operated upon. The joint was opened by a long incision on the mesial side of the patella, which was displaced laterally. The fixation of the joint seemed largely due to a piece of bone which was found to extend forward and mesially from the anterior crucial ligament to which it was intimately attached. After excision of this piece of bone the joint was closed. No splint was used and early motion of the joint was encouraged. X-ray examination showed the subluxation much improved and some of the bony shadows previously seen in the joint to be absent. The bone removed at operation was reported as showing chronic inflammation and fibrosis. The patient was discharged from the hospital a month after the operation. When seen a month later he was still using crutches. Four months later he still had some weakness of the knee, but there was about 75 per cent. normal function. It is now ten months since the operation, and he is able to carry on his work as a laborer.

LATE ULNAR NEURITIS, FOLLOWING FRACTURE; TRANSPOSITION OF THE NERVE

DR. IRA COHEN presented a man now thirty-eight years of age, who was admitted last August to Mount Sinai Hospital with the following story:

NEW YORK SURGICAL SOCIETY

Thirty-two years previously, at the age of six, he fell down a flight of stairs and sustained a fracture of the right elbow. Following this accident he had a deformity of the elbow but no limitation of motion. Two years before coming under observation he first noted numbness in the fifth finger. In the course of time this numbness spread on to the palm and dorsum of the hand. For about the same period of time he noted some weakness of the hand, and that the inner side of the palm of the hand was getting smaller.

On examination he showed some contracture of the fourth and fifth fingers of the right hand. There was atrophy of the hypothenar eminence and of the interossei. There was weakness in flexion of the fourth and fifth fingers with paralysis of abduction and adduction of the last four fingers. Sensation was much diminished over the fifth finger on both its palmar and dorsal aspect. The elbow showed a well-marked deformity, Röntgen examination of which disclosed an old ununited fracture of the external condyle of the humerus.

August 8, under local anæsthesia, the ulnar nerve was exposed on the posterior aspect of the elbow. It was swollen to about three times its normal size and was a deep pink in contrast to the normal color above and below. It felt firm and infiltrated. It was freed from its bed and transposed to the anterior aspect of the joint where it was held by a sling of fascia made from the deep aponeurosis. He was discharged eleven days after the operation. He was seen five weeks later at which time there was a considerable return of power and complete return of sensation. Now five months after operation he still has marked atrophy, but power is improving.

EPITHELIOMA OF GLANS PENIS

DR. KIRBY DWIGHT presented a man, fifty-four years of age, who entered Roosevelt Hospital in May, 1929, with the following history: About six months ago, he noticed a small nodule on the glans penis near the meatus, together with considerable œdema of the prepuce. A few weeks later the nodule broke down. Since that time, there has been a progressive ulceration and erosion of the entire glans and an increasing œdema of the anterior half of the prepuce. He has also had moderate pain in the right groin, but has not noticed swellings in either inguinal region. There is no venereal history. There was marked œdema of the entire penis. There was a deep, irregular ulceration which had destroyed about half of the glans. The edges of the ulcer were raised and hard. A yellowish, purulent exudation could be expressed from several small sinuses. There was infiltration of the entire glans, and of the corpus spongiosum for about 2 inches. The prepuce also was involved. The right inguinal lymph nodes were moderately enlarged and moderately tender. On the left side they were slightly enlarged but not tender. A microscopical examination of a small section removed from the edge of the ulcer confirmed the diagnosis of epidermoid carcinoma, and a few days later a complete amputation was done.

Using gas-ether anæsthesia, a block dissection was made of the inguinal and femoral lymph nodes, cleaning out the inguinal canals and removing the spermatic cords and testes. Then the patient was placed in the lithotomy position. The incision was carried around the base of the penis and down the anterior median raphe of the scrotum. The urethra and corpus spongiosum were divided well away from the cancerous infiltration, about an inch and a half distal to the bulb. Then the corpora cavernosa were dissected well back to the crura, where they were divided and the stumps closed with catgut sutures. An opening was made in the median raphe of

CARCINOMA OF THE RECTUM

the scrotum posteriorly, and the stump of the urethra, after being split on its posterior side for about half an inch, was sutured to this opening. A catheter was introduced and held in place by suture.

Pathological examination of the specimen showed that the line of amputation was well away from the growth. The lymph nodes were found to be hyperplastic but no metastatic tumor cells were found in them. The wounds healed with only a slight infection in the right inguinal region. There was no difficulty in urination and the patient was discharged on the forty-third day.

At the last examination two weeks ago no evidence of recurrence or metastasis was found. At the time of the operation, it was hoped that the patient would be able to urinate standing up without soiling his clothes, but it has turned out that the stump of the urethra is too short to permit it.

CARCINOMA OF THE RECTUM

DR. KIRBY DWIGHT presented a man, aged thirty-one years, who entered Lincoln Hospital in November, 1929, on account of obscure rectal symptoms from which he had been suffering for about one year. On rectal examination, a firm, smooth, projecting, ring-like mass was found about 1 inch beyond the internal sphincter and extending up along the rectum.

A biopsy was done and the diagnosis of colloid carcinoma was made by the pathologist. As soon as the pathological report was received, an exploratory celiotomy was done. The growth was found to be confined to the rectum, not infiltrating the bladder nor adherent to the walls of the pelvis. A few small, hard lymph nodes were felt in the lower part of the meso-sigmoid, close to the bowel. No signs of metastasis in the liver. The large intestine was not dilated nor appreciably hypertrophied. The meso-sigmoid was very short. A left intramuscular incision was made and a permanent colostomy was made following the method of Dr. Charles Mayo. This was done under spinal anaesthesia.

The loop of the sigmoid was opened on the third day and divided on the eighth.

Sixteen days after the colostomy the rectum was removed under spinal anaesthesia. The posterior route was employed, with the patient in the flexed prone position. The gut was amputated a little above the recto-sigmoid junction and the stump of the sigmoid was inverted and closed, and then sutured to the pelvic peritoneum as the opening into the peritoneal cavity was being closed.

The patient was transfused two days before the resection and again ten days after it, 500 cubic centimetres of blood being given each time.

Recovery was without incident except that the plastic work on the colostomy became infected and an extra opening appeared in the angle made by the proximal loop of gut as it entered the subcutaneous tissue. This opening was closed and has remained closed.

The patient now feels well and has gained a good deal in weight. He keeps himself slightly constipated and has no trouble or annoyance from the colostomy. He wears a pad merely as a safeguard. He has not found it necessary to use pressure over the subcutaneous channel of the stoma. He is, however, considerably annoyed by the distal loop of the colostomy. It prolapses about 10 to 12 centimetres when he stands upright. When it is reduced, he has a colicky pain for a few moments. This prolapse is evidently not a result of peristalsis but a hernial protrusion caused by intra-abdominal pressure. The cause of this protrusion, in this particular case, may be the

NEW YORK SURGICAL SOCIETY

short meso-sigmoid, previously mentioned. It prevented the pulling down of as much of the sigmoid as usual at the time of the resection of the rectum. It is planned to re-operate and either to remove the entire distal segment or to resect merely the redundant portion of it.

DR. SEWARD ERDMAN said that Doctor Dwight's explanation of the technic used in attempting a certain degree of control of the artificial anus brought up the question whether any attempts at control by plastic operations are worth while. If the colostomy is conveniently placed and the patient is trained to care for it by adhering to a dry diet and administering a small enema each morning through the colostomy opening, he can establish regular habits and go through the rest of the twenty-four hours without troublesome soiling. The main point Doctor Erdman wished to emphasize was that operations for cancer of the rectum are accompanied by very high mortality and the whole question has not yet been settled as to whether the one-stage or the two-stage method should best be employed. Jones, of Boston, has had excellent results using the one-stage, but Lahey has recently pointed out a logical objection to any one-stage abdomino-perineal operation: namely that if you leave the gut closed you inflict on a patient suffering from the shock of a big operation the additional strain of leaving him with a closed gut. You are therefore causing artificial intestinal obstruction on top of a huge dissecting operation. Doctor Erdman believed that some form of two-stage operation, establishing a colostomy first, was probably the safer method of attacking cancer of the rectum.

DOCTOR DWIGHT agreed with Doctor Erdman in his observation that as a rule plastic work does not help much in the control. Any opening of the gut without a real sphincter is going to be incontinent, unless the patient can make the bowels moderately constipated. In this type of operation, however, leaving in the upper part of the sigmoid, the plastic has value in that the two stomata are separated by normal skin, and a cup can be applied to the proximal stoma without including the distal one. Thus intestinal contents will not pass into the blind distal loop.

CANCER OF THE LARYNX

DR. GEORGE H. SEMKEN presented the following patients:

CASE I.—*Extrinsic Cancer of the Larynx with Early Lymph-node Metastasis.* R. E. McK., aged fifty-one years, a bank clerk, came under observation February 25, 1929. Four months previously, he had noticed a slight sticking sensation on the left side of the throat, during swallowing. This had remained relatively stationary for four to six weeks, then became more noticeable and had progressed continuously since that time. Two months ago, his physician found a small ulcer in the region of the left arytenoid with relatively considerable swelling in the surrounding area. This was considered an inflammatory process, and several applications of some silver solution were made—nineteen in all—during the following two months. There was some pain after the treatments, but this has not been pronounced. There have been no other symptoms beyond an occasional slight "hack"; and there has been no disturbance in speech.

CANCER OF THE LARYNX

The family and personal histories contained no relevant data. There had been no known antecedent cases of cancer and no severe previous illness. Venereal disease was denied, and the patient's Wassermann reaction had been negative. He seldom drank alcoholic liquors, smoked about three cigarettes during the day and two pipes in the evening, and had no unusual occupational factors of throat irritation. His general health was good.

Laryngoscopic examination showed cancer in the left pyriform sinus with extension to the edge of the epiglottis, to the aryepiglottic fold and the arytenoid, and to the lateral wall of the hypopharynx. There was a central excavation approximately 1.0 by 0.5 centimetre in surface diameter. The adjacent regions were hyperæmic and slightly œdematous. The vocal cords and the remainder of the larynx were normal. Upon digital examination, the carcinoma was found to be a stony hard tumor mass, approximately 1.5 to 2.0 centimetres in diameter. It extended to the wall of the hypopharynx but was not yet fixed. In the regional lymph nodes of the neck, there was one enlarged, firm node 2.0 by 1.5 centimetres in diameter, in the left carotid packet, and a smaller, softer node on the right side.

March 5, 1929, a radical laryngectomy was done with the removal of part of the lateral wall of the hypopharynx, well away from the tumor, and the removal, in block, of the related deep cervical lymphatics on each side, from the jugular fossa down to the omohyoid crossing. Colonic oil-ether anæsthesia. The tracheal mucosa was anæsthetized with a small quantity of novocaine 4 per cent. solution, injected into the lumen through a fine needle puncture between two tracheal rings. The trachea was divided transversely, between the cricoid cartilage and the first ring. The trachea was next carefully separated from the œsophagus, drawn into the transverse episternal incision, and sutured into place there with interrupted silk sutures. Four of these, at the main compass points, passed wholly around the first tracheal ring, to unite the trachea firmly to the skin (but they were not tied tightly enough to produce necrosis). The mucosa of the trachea was carefully sutured to the skin with interrupted fine silk sutures. The trachea was thus protected against the danger of aspiration of blood from the further operative procedure.

The skeletonizing of the larynx was now completed by the ligation and division of the remaining inferior and superior vessels respectively, the division of the nerves, and the clearing of the inferior constrictor muscle. A strong suture was inserted around the cricoid cartilage anteriorly, to serve in gently raising the larynx from its bed, and the larynx was dissected free along its posterior attachment, through the lower half of this extent. The wound field was then well protected with moist gauze compresses. The hypopharynx was opened on the uninvaded right side by a vertical incision in the lateral wall, through the inferior constrictor and the hyothyroid membrane. This incision was prolonged at its upper end by a curve mesad, below the hyoid bone, and the tumor region was brought well into view. The hypopharynx was cleansed with a 2 per cent. lysol solution on gauze wipes, and with alcohol; and the final excision was made with curved scissors, (1) across the root of the tongue, (2) across the hypopharynx well below the arytenoids, and (3) widely around the site of the tumor. An Eihorn tube with the Rehfuß tip was passed into the stomach through the opening in the hypopharynx; and the distal end was carried, *via* a catheter, through the pharynx and out of the nose. The large opening in the hypopharynx was completely closed in a Y-shaped line of suture, with interrupted chromic gut in two layers; the anterior edge of each sternocleidomastoid was brought across the large vessels of the respective sides, and sutured to the posterior

digastric above and to the deep fascia below, thus completely separating the vessels and the posterior spaces from the anterior part of the wound, where leakage and infection might occur. Similarly, the space behind the trachea (leading to the mediastinum) was closed with a few chromic gut sutures. The flaps of skin and platysma were brought into alignment and sutured with silk. Drainage was provided (1) at the lowest angle of each closed-off posterior space, (2) at the respective ends of the upper incision, and (3) at the lower end of the mid-line incision. The ends of the sutures at the tracheal opening, left about 4 centimetres long, were fastened to the skin with adhesive strips and the sutures were greased with vaseline (to prevent crust formation).

The patient was returned to bed in good condition and had a relatively normal convalescence. A small accumulation of fluid on the left side required a separate small incision and drainage; and there was a slight leakage of mucus at the mid-line for a time; but otherwise, the wounds healed well. The Einhorn tube was removed on April 15. The microscopical examination of the removed tissue showed squamous-celled epithelioma of the larynx, grade B, with metastasis to the regional lymph node in the carotid packet.

There has been no demonstrable recurrence, one year and eight and a half months after operation. He has had no difficulty in swallowing solid food, and his general health is excellent; but he has not yet learned to speak above a whisper, and does not use the artificial larynx.

CASE II.—*Advanced Mixed Cancer of the Larynx [Intrinsic and Extrinsic]. Laryngectomy with Limited Lymph-node Removal. Recurrence in the Lymph Nodes. Apparent Cure, Two Years and Eleven Months.* Wm. F., aged sixty-six years, a tailor, came under observation September 28, 1925. He had had a cough from chronic bronchitis for many years, and ascribed to this cause also, a hoarseness that began ten months previously. The hoarseness had been progressive and the breathing had been slightly stridulous in the preceding three weeks. There was moderate cough with thick, yellow expectoration. There had been no other symptoms. For a number of months, he had been treated for a "cold." Seven months previously, the diagnosis of cancer had been made by a laryngologist and operation had been advised; but he had consulted another laryngologist, who had treated him with local applications instead, for about six months. The family history was negative for antecedent cancer cases. He had had no previous illness of importance. He seldom took alcoholic liquors; but he had been a continued smoker (cigarettes, cigars or pipe). His general health, apart from the chronic bronchitis, had been good.

Laryngoscopic examination showed a cancerous mass that filled the left half of the cavity of the larynx and had crossed anteriorly to invade the right side also. The site of origin had apparently been in the anterior part of the left ventricular fold, with extension mainly downward into the larynx and forward across the anterior commissure. The growth had also been expansile, and the resultant tumor was an irregularly rounded, smooth mass, red in color with yellowish areas in places where the underlying cancer had thinned out the mucosa. There was apparently no lateral extension, but subsequent examination of the tumor showed invasion of the epiglottis and the left aryepiglottic fold. No enlarged cervical lymph nodes were palpable.

The operation, October 1, 1925, consisted in the removal of the larynx in block with the anterior nodes of the deep chain on the left side, which were considered immediately regional to the process. At the conclusion of the operation, a gastrostomy, by Kader's method, was also done. The procedure followed the plan outlined for the previous case, with the implantation

CANCER OF THE LARYNX

of the trachea in a separate episternal opening; but with the dissection of the lymphatics limited to the node groups anterior to the internal jugular vein. Convalescence was normal. There was no leakage from the pharynx and the wounds healed *per primam*. Liquids were given by mouth on the eleventh day; and the gastrostomy tube was removed on the twenty-fifth day. The gastrostomy closed promptly and this wound was completely healed ten days later. Microscopical examination of the tumor showed squamous-celled cancer.

The date of appearance of the (recurrent) lymph-node tumor in the neck is uncertain, because the patient did not report regularly for the follow-up examinations. December 30, 1926, fifteen months after operation, he had an ellipsoid mass in the upper part of the left side of the neck, 5 by 4 centimetres in diameter, in the region of the superior group of the deep chain. He had noticed this only two weeks previously; and that region had been slightly painful for the preceding few days. There was no evidence of local recurrence; and no enlarged nodes were palpable elsewhere in the neck.

The second operation, January 3, 1927, consisted in the removal of the deep lymphatic structures of the left side of the neck from the jugular fossa to the clavicle, together with a large part of the internal jugular vein and the anterior part of the sternocleidomastoid muscle. The vein had been almost completely occluded by the pressure of the adherent tumor and the muscle had been invaded. Convalescence was uneventful. One month later, there was moderate swelling in the middle zone of the neck which did not disappear. It gave the impression of an inflammatory process, but it was deemed advisable to give deep X-ray therapy to that region, and this has been done. There is still a definite area of thickening, apparently from fibrosis; but there is no evidence of a recurrence of his cancer.

CASE III.—*Intrinsic Cancer of the Larynx—Three-Year Result.* L. S., aged sixty-eight years, came under observation October 10, 1927. A slight hoarseness had been noted ten months previously, and this had continued without appreciable increase until the preceding few weeks. There had been no other symptoms except a moderate increase in mucus. He had been under the care of a laryngologist since the onset, who found a "granuloma" in June; but there had been no active treatment. The condition had been recognized as cancer by a second laryngologist a few days previously. The family history was negative for antecedent cancer cases, and there had been no previous illness of importance. He did not drink alcoholic liquors; but smoked four or five cigars daily and, infrequently, a pipe. There was no other use of tobacco. The use of his voice, as a salesman, may also have been an etiological factor.

Laryngoscopic examination showed a low papillary growth, pink in color, with sessile base, on the upper surface of the cord at the posterior end. It was approximately 0.5 by 0.4 centimetre in diameter, and reached to the ventricle. There was no loss of motion in the cord. No enlarged cervical lymph nodes were palpable. This case seemed objectively a favorable one for laryngofissure, but from the cancer viewpoint, the long duration (ten months) and the proximity to the arytenoid and the ventricle, made it seem wiser to remove the larynx and the immediately regional lymph nodes.

The operation, October 18, 1927, consisted in the removal of the larynx, in block with the lymph-node groups over the carotid bifurcation and just below the posterior belly of the digastric, on both sides. The procedure followed the plan outlined for the two other cases, as to the larynx and the trachea. The lymph-node dissection followed the technic already referred

to, but was simpler because it was limited to the immediately regional groups. An Einhorn tube with the Rehfuß tip was introduced as in the first case reported. The post-operative course was unusually good. The wound healed *per primam*, the Einhorn tube was removed on the tenth day, and the patient left the hospital on the following day. He has had no further evidence of carcinoma. He began to use the MacKenty artificial larynx shortly after the operation and has become very proficient in its use.

DR. J. A. MACKENTY (by invitation) remarked upon the rarity with which cases of laryngeal cancer are seen in their incipency. Last year his records showed 156 cases of cancer in and about the larynx. Most of these began as intrinsic cancer. All but thirty had become extrinsic and only three were truly incipient. Practically all the extrinsic cases were hopeless.

Primary subglottic cancer is rare and in its early stages difficult of detection. It readily escapes into the neck through the cricothyroid membrane and on this account has a much higher recurrence percentage than cancer beginning on the vocal cords.

Out of over 900 cases of laryngeal cancer seen by him in the past twenty-five years only thirty-six were women—all fairly young excepting three. Four of these were unusually young for cancer—thirty, twenty-six, twenty-four and twenty, respectively.

Since the chief warning of laryngeal cancer is in an early hoarseness and since this occurs only in intrinsic, glottic and supraglottic cancer, primary extrinsic cancer, in which the vocal cords are intact, may, and usually does, become well seated before its presence is suspected. Early cancer in this situation is painless and does not, until quite late, affect, in the slightest degree, the general well-being or the voice of the victim. His experience had led him to the conclusion that cancer is far more frequent in larynges which have been the seat of antecedent pathology: Chronic laryngitis, syphilis, rhinoscleroma, papilloma, angioma, hyperkeratosis, prolapse of the ventricle, tuberculosis, etc. In the past two years he had seen two cases of tuberculosis of the larynx, complicated by cancer, and in the far past one case presented, after removal, evidences of tuberculosis, cancer and syphilis.

In intrinsic cancer one or other cord is by far the most common site of inception and strange to say the middle third of the cord is more commonly attacked than the rest of it, due perhaps to the fact that the middle third of the cords sustain the greatest brunt of phonation. About 80 per cent. of all laryngeal cancers are intrinsic at the start and curable by the proper radical treatment.

For primary extrinsic cancer local discomfort as a diagnostic symptom takes the place of hoarseness in primary intrinsic cancer. This with a slight change in the quality of the voice makes careful investigation imperative. Pain radiating to the ear is a later sign but often present. The hypopharynx is, especially in women, the hiding place of incipient cancer. Digital examination is helpful in cancer above the larynx but he doubted its value in early cancer in the larynx. The well-developed intrinsic cancer needs

CANCER OF THE LARYNX

nothing but the eye to label it, since in most instances its appearance is very characteristic. If any degree of success in treatment is expected the diagnosis in extrinsic cancer must be early. The lymphatics may take the disease up at once. This, however, is very variable and depends on the virulence of the disease. Some of the superlaryngeal malignancies are quite benign and slow to invade; especially is this true of cancer on the posterior surface of the epiglottis. He had had two such cases free from recurrence—one for three years and the other for eight years. In neither of these did it seem advisable to remove the glands of the neck. Many cancer patients die from the delay of too many consultations and from the allurements of radium. Unfortunately for them, many select the lethal radium route to eternity.

He believed that biopsy if not properly controlled is dangerous. What is the sense of doing biopsies on a neoplasm with cancer written all over it? In incipient conditions it may be of use. He would warn against it in tuberculosis. Many such cases are thrown over the edge by biopsy. Its findings should not weigh too strongly against negative clinical evidences. In the past ten years he had seen three positive biopsies proved to be wrong.

Laryngofissure may fit the incipient case providing St. Clair Thomson's method is used. But just when is a case incipient? After twenty-five years of inquiry he was still in doubt. Three experiences in recent years had upset his confidence in his former dogmatism. Three larynges with very incipient cancers on the middle third of one cord showed after removal (patients demanded total extirpation) on multiple section, subsurface extensions of cancer to the confines of the larynx. Here laryngofissure would have been a serious mistake. His recurrences after laryngofissure are 35 per cent., but he did not use the Thomson method in the earlier ones.

Lymphatic removal in frankly intrinsic cancer is not justifiable in view of the enormous percentage of no recurrences without it. For cancer outside the larynx it should be practically a routine procedure. Opening the lymphatic areas of the neck adds very materially to the death rate, especially if done when the larynx is removed. There is a lot to be said, however, in favor of doing everything at once and not crossing the cancer field. Several of his recurrences were not in the lymph nodes but in the flaps and some were in the skin. Lymphadenectomy would not have helped there. He had had recurrences *in loco* from six to seventeen years after laryngectomy, showing that cancer infection may remain dormant for years in the local lymphatics and break out only when these areas are subjected to strain from some other infection. He had seen melanotic sarcoma on the cervical and inguinal glands—large dark masses showing through the skin—lie dormant for five years and then overwhelm the patient in a few weeks.

The surgical mortality in his series of cases is under 3 per cent. In incipient intrinsic cancer the recurrences up to 1928 were 3 per cent. Cancer is never cured until the patient dies of some other cause. It is arrested.

He had used the feeding tube by the nasal route, extending into the œsophagus six inches below its mouth, for more than twenty-five years with

NEW YORK SURGICAL SOCIETY

perfect satisfaction and no untoward effects. Gastroenterostomy is never indicated. Anæsthesia is a most important factor in this operation. He preferred scopolamine-morphine-novocaine anæsthesia supplemented by a minimum dose of ether *per ora*.

DR. FRANZ TÖREK said that in cases of extrinsic cancer removal of the larynx is the only operation to be considered. The importance of the removal of lymph nodes involved by the carcinoma is well understood at the present time, although not many years ago this fact was not fully realized. It must not be believed that even after thorough removal of the lymph nodes one can be sure of non-recurrence in nodes, but the percentage of cures is enlarged if the removal of the lymph nodes is radical. It is a great mistake to omit taking out some of the involved lymph nodes for any reason. One cannot trust in the efficacy of X-ray help after an imperfect operation. In this field actinotherapy cannot compete with surgery, in spite of the fact that lymphocytes are strongly radiosensitive. It is a fact that many of these cases are recognized too late. In many instances it is the patient's own fault; he has become accustomed to his hoarseness. It is rather humiliating, however, that these patients should be under the treatment of laryngologists for three months or longer without the discovery of the presence of carcinoma. As to biopsy, most cases can be diagnosticated without it; but there are others in which this cannot be done. It will always be the early cases that are difficult to diagnose. If the new growth has ulcerated its characteristics are more likely to be recognized, but in an early case that has not broken down but manifests itself merely by a thickening of the vocal cords or some other portion, one should do a biopsy. In a word, biopsy will be more necessary in the early cases than in the more advanced. Among the dangers of the operation is that of aspiration of secretions. With constant aspiration of mouth secretions during the operation and by keeping the head suspended, this danger can be minimized. As general anæsthesia increases the danger of aspiration, Doctor Torek prefers the operation under local anæsthesia by anæsthetizing the third and fourth cervical nerves on both sides at the third and fourth cervical vertebræ. By doing so one anæsthetizes all the supraclavicular and cutaneous nerves. A regional infiltration in addition to that will complete the job. Such an anæsthesia usually lasts about two hours and if necessary it can be repeated. There is little pain felt by the patient. The operation has to be done with perfect hæmostasis. It is always bad surgery to work in a pool of blood but particularly so in cancer surgery, for one must be able to see everything distinctly to get around the involved area.

BRIEF COMMUNICATIONS

INTESTINAL OBSTRUCTION COMPLICATING ACUTE APPENDICITIS IN A CHILD OF THREE YEARS

THE following case report presents an unusual combination of features which illustrate the occasional complexity of post-operative observation and care, and the desirability of consultation in difficult cases with experimental and preclinical workers.

The patient was a child three years of age, weighing 38 pounds, who was admitted to the Evanston Hospital November 18, 1930, suffering from acute anterior poliomyelitis and presenting on admission a flaccid paralysis of the left arm and right leg. At the end of two weeks in the hospital, the child began to complain of abdominal pain which soon became localized in the appendiceal region. The abdomen was opened December 2, 1930, and an acutely inflamed appendix, plastered down by adhesions, was removed. During the process of removal the appendix ruptured and a small amount of pus escaped. The subsequent course was tempestuous; temperature 105° , pulse 140, considerable vomiting. By the fifth day, there was marked abdominal distention, projectile emesis, no flatus obtained by enema; 1,000 cubic centimetres of saline mixture were administered subcutaneously and, under nitrous oxide anaesthesia, the bowel was again opened through the left rectus muscle. A greatly distended loop of small intestine was drawn out of the wound and a Witzel enterostomy was made, using a rubber catheter for the tube. Temporary improvement followed this procedure. Frequent saline enemata were given and 10 cubic centimetres of peptonized milk were administered every hour through the enterostomy tube which was clamped for ten minutes after each injection of fluid. Meanwhile the fluid loss from the enterostomy tube was large. In an attempt to decrease this fluid loss, the enterostomy tube was clamped and opened at various intervals. Finally a cradle was placed over the child and the enterostomy tube, some 14 inches of which was outside of the body, was suspended vertically from the cradle with the distal end up and not clamped at all. In this way a vent for gas was continuously present and the weight of the column of fluid in the tube prevented undue fluid loss.

December 10, eight days later, a whole-blood transfusion of 250 cubic centimetres was given, the cannula was left tied in the patient's vein so that every ten minutes 5 cubic centimetres of dextrose-Ringer's solution might be allowed to flow into the vein. Moderate reaction to the blood transfusion occurred; pulse 146, temperature 104.8° ; repeated gastric lavage. The fluid intake was as follows: oral, 190 cubic centimetres; through enterostomy tube, 476 cubic centimetres; intravenous, 965 cubic centimetres; total, 1,631 cubic centimetres. The output was: urine, 330 cubic centimetres; drainage from enterostomy tube, 690 cubic centimetres; total, 1,020 cubic centimetres.

At this point, because of the involved physiological considerations, Dr. A. C. Ivy, Professor of Physiology at Northwestern University Medical School, was called into consultation. Doctor Ivy proposed the employment of a food for intestinal feeding which had been evolved in his department by Dr. H. G. Scott and which had been used successfully in animals.* The formula, permission to publish which has been courteously accorded by Doctors Ivy and Scott, is as follows: Milk, 3 quarts; water, 3 quarts; dried peptone (Merck), 100 grams; cane sugar, 150 grams; wheat flour, 300 grams. In the

*Full details concerning the experimental consideration by which this formula was obtained will shortly be published by Professor A. C. Ivy and Dr. H. G. Scott in a separate communication.

BRIEF COMMUNICATIONS

preparation of the food, to the water add the sugar and heat to 130° F. and add the peptone; heat for four minutes, then add this solution gradually to the flour, making a paste, then add all the milk. The mixture is then brought to 212° F. and heated at the sub-boiling temperature for three minutes, or longer, until the solution is about as thick as cream soup. One hundred cubic centimetres of this food were administered by the enterostomy tube every two hours, taking care to drain the tube first. After twenty-four hours, 5 grams of sodium chloride were added to each quart of the food. The quantity was reduced to 50 cubic centimetres every two hours. On this day also, the appendectomy incision was explored laterally by finger and an abscess cavity opened up from which 2 ounces of pus escaped. A counter incision was made through the right flank into this cavity and drains were inserted.

On the following day, it being evident that the bowel was not tolerating well the quantities of fluid which were injected into it, and the child being able but poorly to swallow fluids that were administered orally, a nasal feeding tube was passed through the nose into the stomach and 50 cubic centimetres of the "food" were injected through this tube into the stomach. Every two hours thereafter, this procedure was repeated, alternating with 25 cubic centimetres of the "food" every two hours by the enterostomy tube. Gradual increase in the amount of food administered by the nasal tube marked the next two days. The nasal tube was aspirated before each injection to ascertain the presence or absence of fluid in the stomach. The child improved rapidly and on December 16, 1930, there was a liquid defecation. On the 18th and 19th there were several small stools, but on the 20th, symptoms of obstruction again developed. It seemed probable that an acute strangulation of the bowel was taking place so that on December 22, under avertin and ether anaesthesia, the abdomen was again opened through a left paramedian incision after observing great care in the skin preparation. A loop of the small bowel was found densely adherent to the anterior abdominal wall in the region of the original right paramedian incision. This adhesion had caused an acute angulation of the bowel which almost obliterated its lumen. The bowel was freed from this attachment and dropped back into the abdomen. The wound was closed; hypodermoclysis of normal saline given. The patient withstood this very well and from then on convalescence was uneventful. The enterostomy tube was removed on December 23, bowel movements began on the same day and have continued regularly since. As the patient's strength improved, the nasal feedings were gradually decreased and oral feedings were increased. There had been a definite regression of the paralysis of the left arm. December 31, a small abscess which had developed in the final incision was drained. January 7, 1931, all wounds were healed, the child was happy and normal in appearance, and was discharged from the hospital.

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Surgeon: Evanston Hospital.

"ANCHORING" RADON SEEDS AT BASE OF TONGUE

IN A paper published five years ago (ANNALS OF SURGERY, vol. lxxxiii, p. 598, May, 1926) I first advocated the use of removable platinum radon seeds in the treatment of malignancy of the tongue. I stated that I had found this new applicator capable of "complete intra-neoplastic insertion, so that there is no chance of dislocation nor expulsion," and that the fact that the seed is completely buried in the malignant tissue gave it a great advantage over the platinum needle "as regards retention of position and non-interference with function of the surrounding parts." After using the

ANCHORING RADON SEEDS IN TONGUE

method very extensively for more than five years I now find that while my first experience has remained uncontradicted in most cases, situations occasionally arise when my original position must be somewhat modified. Deeply implanted seeds regularly remain in position for as long a time as we desire to keep them there. Now and then those placed near the surface show a tendency to become dislodged by the continuous mobility of the parts involved. Though such a situation was decidedly rare, its very frequency made it particularly distressing when it did occur.

I have now devised a plan of "anchoring" superficially placed seeds which will, I trust, do away with any possibility of their being accidentally dislodged. The device which I am about to describe is the outcome of practical experience, and the chastening influence of a few failures and disappointments. It is particularly designed for such situations as the pharynx, hitherto regarded by many radium therapists as a place where implantation was impractical and for the tongue or other parts where mobility is so great as to interfere seriously with the retention of such foreign bodies as metal radon seeds.

The danger commonly apprehended by those unfamiliar with radium technic is that the seeds will "fall out." This does, of course, occasionally happen. A far more frequent situation, however, is the migration of the seeds from their original positions so that the radiation they give off is not properly distributed. In one case of which I have knowledge wherein permanent implantation was employed, all the seeds distributed through a lesion at the base of the tongue worked their way through the tissues until they were concentrated at one spot. This made the radiation at that point so intense that necrosis was inevitable and the entire tongue eventually sloughed off as a result. This was, no doubt, an extreme case, yet the dangers which it illustrates are always present when seeds are permanently implanted in areas where considerable mobility is inevitable. "Anchoring" seeds in such a situation is a safeguard imperatively demanded.

To carry out the new technic which I have mentioned, it has been necessary to convert the loading-slot implanter—which bears a certain resemblance to a breech-loading firearm—into a "muzzle loader." The seeds which were formerly placed in the loading-slot and pushed down the barrel of the instrument by the insertion of the obturator are now inserted into the point of the implanter as shown in Fig. 1.

In Fig. 2 is shown a curved implanter with the seeds inserted as in Fig. 1. Fig. 3 indicates how the needle-like implanter with the point carrying the thread (inserted point first and thread-end protruding) is thrust into the tissues at the base of the tongue. The point emerging, as shown in Fig. 4, the thread forms a loop about it which may be caught by a second pair of forceps and drawn out as shown in Fig. 5. In Fig. 6 the loop is pictured drawn down to make a knot, the final position of which in relation to the seed is illustrated in Fig. 7.

BRIEF COMMUNICATIONS

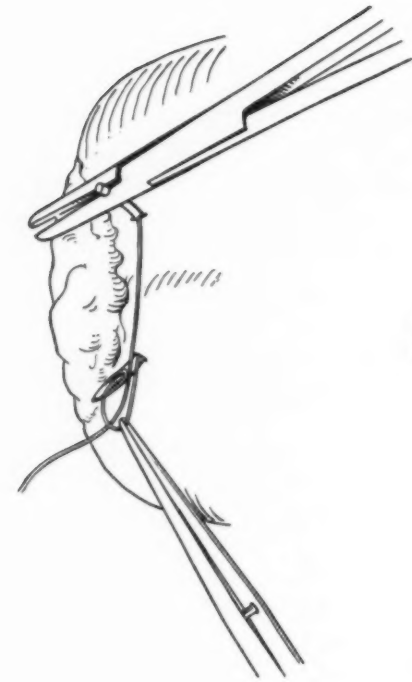


FIG. 1.



FIG. 2.

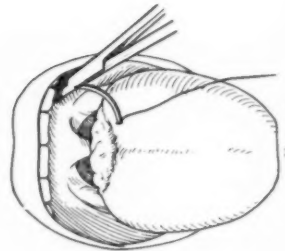


FIG. 3.

FIG. 4.

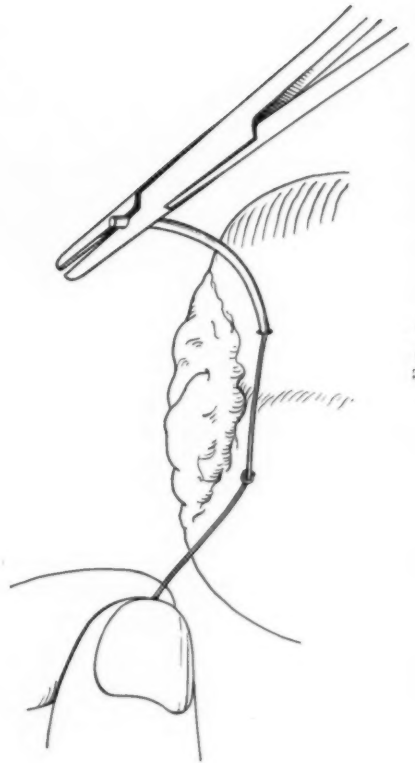


FIG. 5.

FIGS. 1 to 9.—Showing steps in anchoring radon seeds in a tongue.

ANCHORING RADON SEEDS IN TONGUE

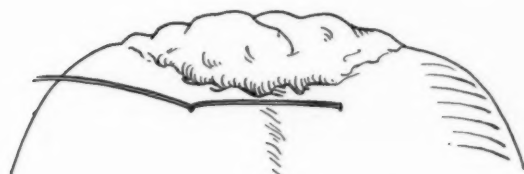


FIG. 6.

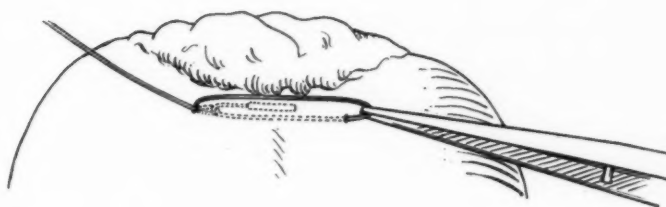


FIG. 7.

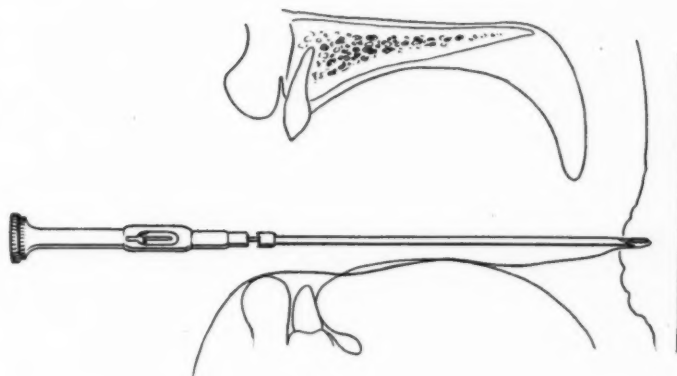


FIG. 8.

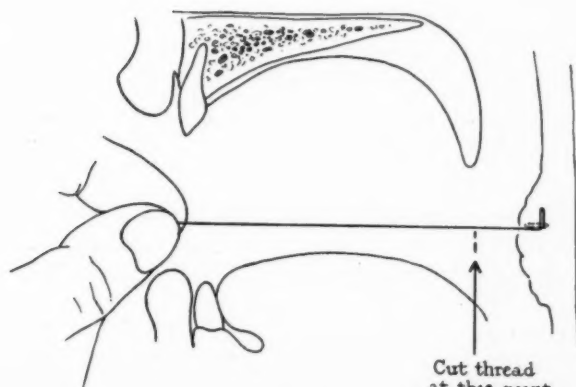


FIG. 9.

Cut thread
at this point

BRIEF COMMUNICATIONS

In Figs. 8 and 9 is shown a method of "anchoring" the seed in the wall of the pharynx, which has already been mentioned as an exceptionally difficult situation in which to insure even distribution of the radioactive centres for the length of time necessary to give adequate dosage. The seed is placed in the point of the implanter with the thread-end protruding. When the implanter is thrust into the tissue the thread precedes the seed as shown in Fig. 8. The instrument being withdrawn, gentle traction is exerted upon the thread, so that the angle at which the seed lies is changed. Its position is now perpendicular instead of horizontal. Traction also causes the thread to loop about the end of the seed, making it much more difficult to dislodge than would otherwise be the case. The thread is then cut off as close to the pharyngeal wall as possible, only enough thread being left to permit forceps to take hold for later removal of the seed.

The implantation of lesions of the mouth and throat will be found greatly facilitated by the employment of these simple safeguards. The assurance that the seeds will neither fall out nor migrate from the position in which they were originally placed permits the physician to proceed with more confidence, while the actual advantages of proper distribution in all situations are so great as to enhance the value of the treatment to a very appreciable extent.

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NECROSIS OF URETER

FOLLOWING REPEATED INJECTIONS OF MERCUROCHROME AND SILVER NITRATE SOLUTIONS

FORTUNATELY, destruction of the ureter by chemical injections in the course of diagnosis or treatment is rare, so far as we have any published reports. Such reports as I have seen are those of the accidental introduction of caustic chemicals in an effort to make diagnostic ureteropyelograms. This occasional catastrophe has resulted in many clinics refusing to allow bilateral injections for pyelograms at one sitting. In none of these reported cases have I seen any ureterograms taken after the destructive injection, so that the X-ray appearance of the ureter ulcerated as a result of destructive chemical injections is not a matter of record. I have seen no picture of it, that we may compare its destructive lesion with the ureter ulcerated as a result of infection, such as tuberculosis. It is to fill this vacancy in our album of ureterogram pathology that I wish to place on record the following case of the ureter ulcerated by injected chemicals.

Mr. X., a young man, was taken sick with dysuria and frequency and was sent to the local hospital for urological examination by the attending urologist. He was running the temperature of acute pyelitis, and the report after cystoscopy was pyelitis with cystitis. A bilateral ureteropyelogram was taken. (See Fig. 1.) Although the picture is poor it is good enough to demonstrate the normally smooth right ureteral wall. The

CHEMICAL DESTRUCTION OF URETER

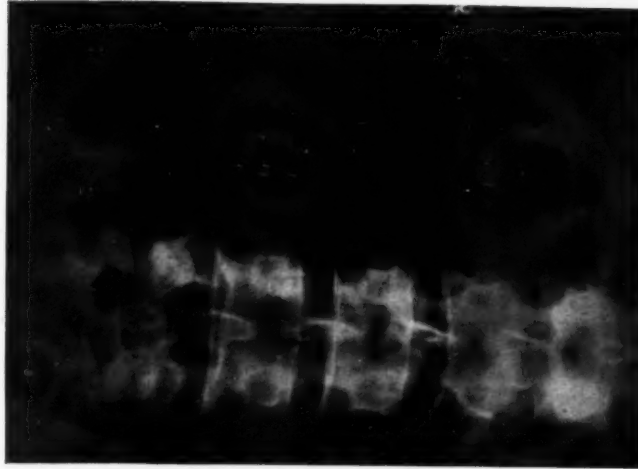


Fig. 1.—Ureterogram on admission to hospital. Note smooth, normal margin.



Fig. 2.—Ureteropyelogram made eight weeks after Fig. 1 was made. Note the dilated, ragged, ureteral outline.

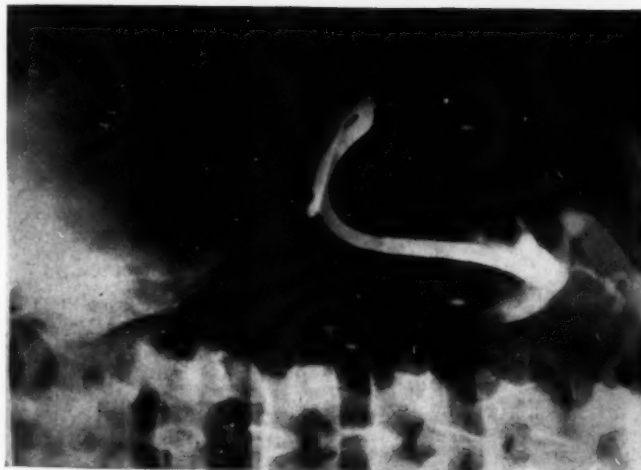


Fig. 3.—Tube in kidney following pyelotomy. Note sodium iodide can not be made to go down ureter.

BRIEF COMMUNICATIONS

right kidney was sterile and functioning normally. The treatment consisted in forced fluids and rest. His temperature was normal in five days and the patient went home. The condition promptly recurred and he returned to the hospital, where he was recystoscoped and catheters left up both ureters. On this examination the laboratory reported pus from both kidneys. No pyelograms were taken and the catheters were left in position in the ureters for fifteen days. Each day the catheters were washed out with sterile water and there were injected into them 2 cubic centimetres of 1 per cent. mercurochrome and 3 cubic centimetres of 1 to 2 per cent., silver nitrate.

At no time during these injections did the patient complain of any unusual right-sided pain. In fact, the bedside notes refer to left renal pain.

The patient's condition did not improve. After he had been ill about eight weeks he came to the Hartford Hospital under my care in an extremely serious condition. At this time the symptoms were severe pain in the right kidney and dysuria, his temperature varying from 102° to 105°. I then cystoscoped him and got a double ureteropyelogram, as seen in Fig. 2.

He was so ill that I felt he would not stand a nephrectomy, so I did a nephrotomy under local anesthesia and placed a tube into the kidney pelvis, as shown in Fig. 3. No effort was made to explore the ulcerated right ureter. We subsequently made many examinations for tubercle bacilli, with negative findings. X-rays of the chest revealed no sign of tuberculosis. Yet because of the ragged appearance of the right ureter, I made a diagnosis of probable tuberculosis.

After about two months' draining through the pyelotomy wound, the patient recovered enough for a nephro-ureterectomy. My diagnosis was still probable tuberculosis. I promised this boy's friends to take out his kidney and attempt to remove his large ulcerated old ureter. Imagine my surprise at not finding this ureter when I looked for it. I decided to free the kidney up first and in that way locate the ureter. The kidney was easily freed up in spite of the old adhesions. I severed the vascular pedicle and lifted this kidney right out of the wound. There was no ureter below the pelvis. My dissection was very clean, even down to below the iliac vessels, but nowhere was there any trace of the ureter left. The wound was drained. Following this operation the patient made an uneventful recovery.

When I realized that I had been dealing with a pathological condition following the injection of chemicals in the ureter, I reexamined the old bedside notes, and there is no record of the injection into these kidneys of anything but 12 per cent. sodium iodide for the first pyeloureterogram and later, during the fifteen days that the catheters lay in the ureter, the injection of the 2 cubic centimetres of 1 per cent. mercurochrome and 3 cubic centimetres of 1 to 2 per cent. silver nitrate.

It is difficult to speculate as to just what chemical destroyed this ureter and why the destruction was unilateral, when catheters were presumably up each ureter. One is forced to choose from the following possibilities: Either the catheter slipped out of the left ureter without this fact being recognized and some unrecorded corrosive was accidentally injected; or else different chemicals were injected into the two catheters, that to the right being accidentally strong, which was unlikely; or else there was some mechanical condition in the right side which prevented the outflow of the mercurochrome and silver nitrate after it was injected, so that these small amounts, at the dilution used, were sufficient, when repeated daily over fifteen days, to cause destruction of the ureter.

MIKULICZ OPERATION CLAMP

So far as the actual evidence at hand is concerned the last supposition seems most probable.

Therefore, it is especially important that the possibility of such a disaster must be kept in mind by all surgeons who are injecting repeated doses of 1 per cent. mercurochrome or 1 to 2 per cent. silver nitrate, or the combination of the two, especially where these corrosives may return down the ureter around the catheter and be retained in the ureter by a tight sphincter. It is well known that 1 per cent. mercurochrome when it leaks around a vein after intravenous injection, becomes destructive in its effect on the tissues.

CONCLUSIONS

1. A ureterogram showing a destructive ureteritis the result of the injection of corrosive chemicals is here presented.
2. The similarity of this picture to tuberculous ureteritis is noted.
3. It would seem that the repeated injections of 2 cubic centimetres of 1 per cent. mercurochrome and 3 cubic centimetres of 1 to 2 per cent. silver nitrate into retained ureteral catheters, if done as often as once a day for fifteen days in succession, has the potentiality of destroying the ureter under conditions, as yet unknown, but very possibly when the return flow is poor because of some ureteral spasm.

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MIKULICZ OPERATION CLAMP

IN THE Mikulicz stage operation for tumors of the sigmoid flexure of the colon, the clamps generally used to cut through the double-barrel spur of the bowel are awkward and cumbersome with the long handles protruding

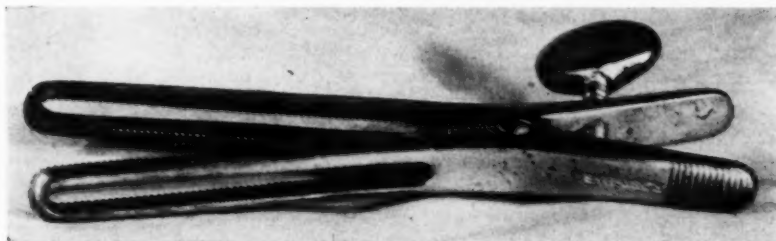


FIG. 1.—Mikulicz operation clamp to crush through the contact areas after double-barrel spurs in cases of tumor of the sigmoid flexure of the colon.

far above the dressings. The clamp worries the patient and requires careful handling to avoid pulling or tearing out of the bowel.

The instrument herein illustrated and described avoids all the disadvantages of such a clamp and functions very well in making the opening between the two loops of colon long enough and sufficiently wide for good function

BRIEF COMMUNICATIONS

and a successful anastomosis. It may be used after removing the exposed tumor by the old method or following the use of the Fred Rankin crusher.

The instrument is $5\frac{1}{4}$ inches long. The crushing blade is $3\frac{1}{2}$ inches from the centre of the screw in the joint. The width of the crushing blade is seven-sixteenths of an inch. The open portion of the blade is four-

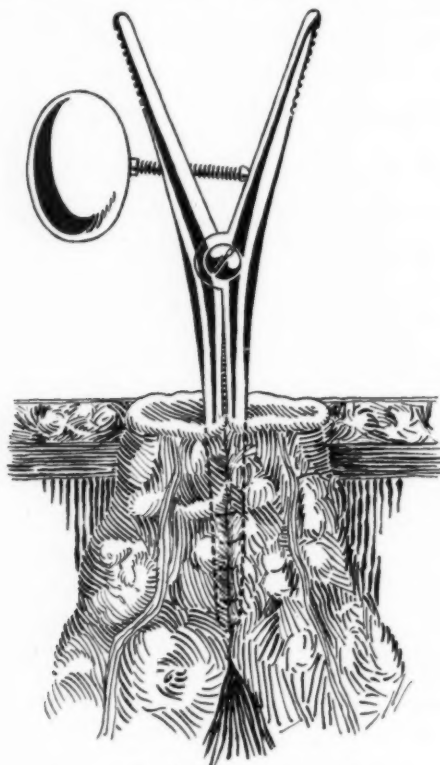


FIG. 2.—Shows the clamp in position.

sixteenths of an inch across and $2\frac{3}{4}$ inches long. The teeth intermesh so there is no danger of the instrument's slipping, once it is set and screwed tight. When the blades are in position for crushing, the set screw is tightened and the crusher thus held firm. The dressings are placed around the handles.

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DISPOSITION OF THE HEAD OF THE FIBULA IN HIGH AMPUTATIONS OF THE LEG

THE part of fibula left in a stump not connected with the tibia and under little or no muscular control frequently becomes a menace. It does not synchronize with the movements of the tibia when an artificial limb is being worn. Consequently there is a disturbance of the tissues between the bones. In some cases this disturbance causes pain. In other cases it induces a

DISPOSITION OF HEAD OF FIBULA

thickening of the tissues and in other cases it induces a tumor, which takes on growth continually and finally forces the bones apart. An artificial leg fitted perfectly when delivered will be a painful thing to the wearer when the fibula is forced so far away from the tibia that it brings pressure on the walls of the socket.

The artificial limb maker, of course, is called upon to remove material to accommodate the fibula and relief is obtained. But in a very short time the fibula, having continued in its travel, reaches the wall of the socket under pressure and removal of further material is necessary. This continues until the socket is completely cut away and a new one is necessary, or the wearer is obliged to buy a new leg complete, but in many cases it has induced the wearer to abandon the use of an artificial leg.

The fibula is the most sensitive bone in the entire leg. No part of it will endure pressure for any length of time. This is a bone that is not necessary to control a limb. The tibia is equal to meet all demands. Why then let the remains of the fibula remain in the leg?

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BOOK REVIEWS

ABDOMINO-PELVIC DIAGNOSIS IN WOMEN. BY ARTHUR JOHN WALSCHIED, M.D. 8 vo.; cloth; pp. 1000; C. V. Mosby Company, St. Louis, 1931.

Too many of our recent books on Gynæcology have been practically merely illustrated works for quick reference showing an operation fitted to a particular condition, and tending to carelessness on the part of the great majority of men. This is an excellent book to be used as a reference work for those who wish to improve their diagnostic ability and technic, and is devoted in its entirety to that purpose. The introductory chapter includes a study of posture and poise, which elements are generally recognized as having an immense influence on the possibilities of the development of characteristic gynæcological conditions. The chapter on etiologic factors is complete and very helpful. This is followed naturally by the symptomology which would accrue from a knowledge of the first two chapters. It is noted that no mention of *trichomonas vaginalis* as a cause of vaginitis is made. This is the only serious criticism of the volume.

The special chapters on the diseases of the various organs are not verbose but contain all the salient points necessary for a complete study of an individual case. The author has been very liberal in giving credit to his references and has produced an index in keeping with the remainder of his work. One will learn from this book not so much how to operate but rather when to operate, and it should be considered as a companion work to all books of operative gynæcological technic.

ALBERT M. JUDD.

COLLECTED PAPERS FROM THE SECOND SURGICAL DIVISION OF THE NEW YORK HOSPITAL. BY THE SURGICAL STAFF, 1930.

The last collection of papers by the staff of this division was effected in 1923 and consisted chiefly of follow-up studies or late results. The present volume contains some twenty-eight articles dealing largely with the same phase of surgical research, in the preparation of which seven members of the staff have participated.

The volume is well bound in cloth and contains 276 pages with numerous illustrations, the publishers' reprints of the various articles having been used in its construction. They lend themselves fairly well to this procedure. This effort of the Second Division of the New York Hospital is to be highly commended in that it not only indicates the literary activities of the members of the staff but adds impetus to the preparation of future studies when the author appreciates that in such a volume his efforts will receive further consideration.

JAMES T. PILCHER.

EDITORIAL ADDRESS

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Remittances for Subscriptions and Advertising and all business communications should be addressed to the

ANNALS OF SURGERY

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Philadelphia, Penna.

1120